PART I

Applying Nutrition in Community and Public Health

© olies/Shutterstock.

CHAPTER 1

Applying Nutrition Science to the Community and Public's Health

Nina Current, MS, RDN, LDN

(We would like to acknowledge the work of Carol E. O'Neil, PhD, MPH, RDN, LDN, and Theresa A. Nicklas, DrPH for their work on past editions of Nutrition in Public Health.)

Learning Outcomes

AFTER STUDYING THIS CHAPTER AND REFLECTING ON THE CONTENTS, YOU SHOULD BE ABLE TO:

1. Explain how and why nutrition policies, programs, and practice must be evidence-based.
2. Evaluate the peer-reviewed literature and assess bodies of evidence used to form nutrition policies and recommendations.
3. Compare and contrast different types of research studies and explain how they are used to form policies, programs, and consumer information.
4. Explain how and why nutrition policies, recommendations, and programs are changed at regular intervals.
5. Use the same resources as community and public health dietitians/nutritionists to keep up with current research or available programs that are grounded in research.

List of Abbreviations

Academy:	The Academy of Nutrition and Dietetics
AI:	Adequate Intake
ARS:	Agricultural Research Service
ATBC:	Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study
BHS:	Bogalusa Heart Study
BMI:	Body Mass Index
BRFSS:	Behavioral Risk Factor Surveillance System
CARDIA:	Coronary Artery Risk Development in Young Adults
CARET:	Carotene and Retinol Efficacy Trial
CNPP:	Center for Nutrition Policy and Promotion
CDC:	Centers for Disease Control and Prevention
CHD:	Coronary Heart Disease
CSFII:	Continuing Survey of Food Intake by Individuals
CVD:	Cardiovascular Disease
DASH:	Dietary Approaches to Stop Hypertension
DGA:	Dietary Guidelines for Americans
DHKS:	Diet and Health Knowledge Survey
DRI:	Dietary Reference Intakes
DV:	(Percent) Daily Value
EAL:	Evidence Analysis Library
EAR:	Estimated Average Requirement
ERS:	Economic Research Service
FAO:	Food and Agriculture Organization of the United Nations
FFQ:	Food Frequency Questionnaire
FHS:	Framingham Heart Study
FNB:	Food and Nutrition Board (Health and Medicine Division, National Academies of Sciences, Engineering, and Medicine)
FNS:	Food and Nutrition Service (USDA)
HHANES:	Hispanic Health and Nutrition Examination Survey
HHS:	(Department of) Health and Human Services
HMD:	Health and Medicine Division (National Academies of Science, Engineering, and Medicine
HNIS:	Human Nutrition Information Service (USDA)
HP:	Healthy People
IOM:	Institute of Medicine (National Academies of Sciences, Engineering, and Medicine)
LDL-C:	Low-density Lipoprotein Cholesterol
NCCDPHP:	National Center for Chronic Disease Prevention and Health Promotion (CDC)
NCI:	National Cancer Institute
NCHS:	National Center for Health Statistics
NFCS:	Nationwide Food Consumption Survey
NESR:	Nutrition Evidence Systematic Review
NHANES:	National Health and Nutrition Examination Survey
NHLBI:	National Heart, Lung, and Blood Institute

NIA:	National Institute on Aging
NIH:	National Institutes of Health
NHIS:	National Health Interview Survey
NHS:	Nurses' Health Study
NLEA:	Nutrition Labeling and Education Act of 1990
NNMRRP:	National Nutrition Monitoring and Related Research Program
OCPHP	Office of Disease Prevention and Health Promotion
PedNSS:	Pediatric Nutrition Surveillance System
PL:	Public Law
PNSS:	Pregnancy Nutrition Surveillance System
QHC:	Qualified Health Claims
RACC:	Reference Amount Customarily Consumed
RDA:	Recommended Dietary Allowances
RCT:	Randomized Controlled Trial (or Randomized Control Trial)
SNDA:	School Nutrition Dietary Assessment Study
SNAP:	Supplemental Nutrition Assistance Program
TDS:	Total Diet Study
UL:	Tolerable Upper Intake Level
USDA:	United States Department of Agriculture
WHO:	World Health Organization
WIC:	Special Supplemental Program for Women, Infants, and Children
YRBSS:	Youth Risk Behavioral Surveillance System

Introduction

Prior to the 1970s, community and public health nutrition was primarily focused on feeding programs and preventing nutrient deficiency diseases. Early in the 20th century, there was a general lack of understanding of the relationship between diet and disease, and diseases such as pellagra (niacin deficiency) and rickets (vitamin D deficiency) were common. As food availability improved and the prevalence of deficiency diseases decreased, there was a growing awareness that dietary excess and imbalance increased the risk of developing chronic disease, such as coronary heart disease (CHD), hypertension, type 2 diabetes mellitus, and cancer.[1]

In 1977, the US Senate Select Committee on Nutrition and Human Needs, under Senator George McGovern, issued *Dietary Goals for the* United States.[2] The goals engendered controversy among health professionals and the food industry because of how they were conceived and presented. At that time, there was also a lack of consensus on the impact of food/nutrients on chronic disease risk. In retrospect, the authors of these dietary goals were remarkably perspicuous. The statement by Dr. C. Edith Weir, Assistant Director of the Human Nutrition Research Division, U.S. Department of Agriculture (USDA), that "Most all of the health problems underlying the leading causes of death in the U.S. could be modified by improvements in diet"[2] remains the cornerstone of public health nutrition and nutrition policy in the United States.

Today, the preponderance of epidemiologic, clinical, and laboratory data have clearly linked both diet and physical inactivity with chronic disease.

Pandemic Learning Opportunity

Since the COVID-19 pandemic, the leading causes of death may have changed, with the corona virus landing in the top five. This has been a community and public health disaster.

National Health and Nutrition Examination Survey Is a program of studies designed to assess the health and nutritional status of adults and children in the United States. The survey combines interviews and physical examinations and is free to the public.

The World Health Organization's report on the Commission on Ending Childhood Obesity can be found online at https://apps.who.int/iris/bitstream/handle/10665/204176/9789241510066_eng.pdf

Information on obesity and obesity trends in the United States can be found on the website of the CDC: http://www.cdc.gov/obesity/data/prevalence-maps.html

Five of the 10 leading causes of death—heart disease, cancer, stroke, diabetes mellitus, and kidney disease—are related directly to poor diet, physical inactivity, and other lifestyle factors.[3] The cost of these diseases, both in terms of direct patient care and lost productivity, to the United States is staggering; for example, in 2014, heart disease and stroke cost approximately $329.7 billion dollars with $199.2 billion dollars being spend on direct patient care.[4] In 2010, cancer care cost $157 billion dollars.[5] In 2017, diagnosed diabetes mellitus cost $327 billion dollars with $237 billion dollars going to direct medical costs.[6] All stages of chronic kidney disease (including end-stage) cost Medicare $120 billion. The chronic disease cost calculator provides additional information about the cost of chronic diseases at the state level.[7]

Not included among the five major causes of death, but a major contributor to these and other health problems, is obesity. Obesity has reached epidemic proportions. **National Health and Nutrition Examination Survey (NHANES)** data from 2015 to 2016 showed that among adults, 38.0% of males and 41.5% of females were obese or had a body mass index (BMI ≥30).[8] The prevalence of obesity among U.S. children 2–19 years of age was 18.5% from 2015–2016. The prevalence of obesity among children 2–5 years of age (13.9%) was lower than among children 6–11 years (18.4%) and adolescents 12–19 years (20.6%). The same pattern was seen in males and females, with the exception of boys aged 6–11 years (20.4%) roughly equal to boys 12–19 years (20.2%)—girls in those age groups were more similar to the total trend.[9] Obesity in children is calculated differently than in adults since the relationship between BMI and body fat in children varies with age and pubertal maturation; thus, a single cutoff cannot be used for all ages. For children, a percentile range on the Centers for Disease Control and Prevention (CDC) growth charts is used: less than the 5th percentile is underweight, the 5th to <85th percentile is normal weight, 85th–<95th percentile is considered obese, and ≥95th percentile is considered obese.[10]

A significant increase in obesity in adults and children was seen from 1999–2000 through 2015–2016; however, no change was seen in children between 2003–2004 and 2013–2014. No significant change in obesity prevalence among adults or children was seen between 2013–2014 and 2015–2016.[9] In the United States, current estimated total medical costs of obesity in 2013 was $342.2 billion.[11] It is crucial to work toward reducing disease risk and promoting healthy behaviors in all individuals. Read more about childhood obesity in Chapter 9.

These health problems are not unique to the United States. Globally in 2016, noncommunicable (chronic) diseases accounted for 71% of all deaths (41 million people), 85% of whom lived in low- or middle-income countries.[12] Over the next decade, it is estimated that 55 million annual deaths worldwide will occur as a result from these diseases. The World Health Organization (WHO) has acknowledged the priority for addressing noncommunicable diseases globally. Achieving better health outcomes for these diseases "is a precondition for, an outcome of and an indicator of" economic development, environmental sustainability, and social inclusion.[13] The WHO finalized a global strategy to improve diet and increase physical activity to reduce the risk of chronic noncommunicable diseases while continuing to carry forward the long-term WHO goals in other nutrition-related areas, including undernutrition.

Relatively few modifiable risk factors—such as lack of fruit and vegetable intake, abnormal weight gain, smoking, inappropriate use of alcohol, and physical inactivity—cause the majority of the chronic disease burden. Changes in diet and physical activity patterns can significantly reduce disease

risk, often in a surprisingly short time period. In 2018, a large proportion of cardiovascular disease in the United States was attributable to just seven risk factors: dietary risks, high systolic blood pressure, high BMI, high total cholesterol levels, high fasting plasma glucose levels, tobacco smoking, and low levels of physical activity. The largest contribution to cardiovascular disease risk comes from dietary factors.[14] However, healthy diet is the least likely heart healthy behavior to be achieved by American adults. In 2012, nearly 10% of cardiometabolic deaths (66,508 of 702,208 total cardiometabolic deaths) were attributed to high sodium intake; this represents a 6% increase over a 10-year period. A total of 318,656, or 45%, of cardiometabolic deaths are attributable to poor dietary habits in general. The role of **public health dietitians/nutritionists** is crucial in working to reduce risk for this and other chronic diseases in this country.

Public health nutritionist An expert in food and nutrition who applies this expertise to nutrition research, practice, and policy to improve the health of populations.

Community and Public Health Nutrition and Public Health Dietitians/Nutritionists

The National Academy of Medicine Initiative, as part of the *Vital Directions for Health and Health Care* series, released a 2016 discussion paper (*Advancing the Health of Communities and Populations*) defining public health as "[a]ddressing social, behavioral, and environmental factors that discourage healthy eating patterns or promote unhealthy exposures like smoking" in a manner that "ensures conditions in which people can be healthy."[15] In 2011–2012, the Institute of Medicine's (now known as the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine) Board on Population Health and Public Health Practice redefined public health and clinical medicine as simply "the health system" public health dietitians/nutritionists are a vital part of that system.[16] Priorities for health care in America in 2021 include addressing health costs and financing, optimizing health and well-being for women and children, transforming mental health and addiction services, actualizing better health and health care for older adults, and improving the country's resilience against future infectious disease threats.[17]

Community and public health dietitians/nutritionists need to be able to understand what drives food and physical activity choices by consumers. Eating motivations involve many elements besides hunger including physiological factors, psychological factors (e.g., emotional state, disordered eating), social reasons (e.g., cultural, religious), socioeconomic factors (e.g., accessibility, availability, and affordability), and food sensation (e.g., smell, appearance, taste).[18-22] The decision not to engage in regular physical activity may be driven by lack of knowledge and attitudes about physical activity recommendations, lack of a safe place to exercise or of social support, lack of access to programs, and time.[23,24] However, there also may be strong psychological factors related to initiation and maintenance of exercise.[25]

Without the knowledge of why different populations choose healthy foods or choose not to exercise, it is difficult to understand why people eat what they do, why they do or do not engage in physical activity, or why they are or are not able to plan interventions and design policies and recommendations that change behavior that will lead to a healthier lifestyle.

Community and public health dietitians/nutritionists need to have a broad grasp of the sciences, including the pathophysiology of disease, genetics, biotechnology and its impact on sustainable agriculture, nutritional biochemistry and molecular biology, nutrigenomics, informatics, biostatistics, epidemiology, psychology, sociology, and nutritional sciences. Finally, community and public health dietitians/nutritionists need to know what information and resources

are available to them to help plan and assess programs at the national, state, local, or individual levels.

Today, for consumers and health professionals alike, there is a bewildering array of diet and physical promotion information available on the Internet, social media, and through other media channels and it can be difficult to determine fact from false claims.[26,27] On discussion forums for online nutrition courses, over 50% of the sources that learners used for food- and nutrition-related information came from online websites and only 5% of food- and nutrition-related information shared on the forums was written by a nutritional professional.[28] It is vital that health professionals, including registered dietitians, provide timely, accurate online information,[29] and help consumers understand that not all available information is accurate and help them understand how to distinguish sound science from less credible information. To do this, we, as health professionals, need to understand how to evaluate information.

In this chapter, we will look at examples of how to interpret and evaluate the professional literature to 1) make **evidence-based practice** decisions in community and public health; 2) learn the science behind nutrition recommendations, policy, and legislation; and 3) find ways for nutritional science to be translated into messages for consumers.

Evidence-based practice Is the conscientious effort to use the best available evidence when making clinical decisions.

Nutrigenomics Is the study of the effects of food or food components on gene expression and how individual genetic differences can affect the way we respond to foods or nutrients.

Strategy Tip

The second edition of detailed recommendations for physical activity were published in 2018 by the Department of Health and Human Services (available at health.gov/our-work/physical-activity/current-guidelines)

Discussion Prompt: Research

nutrigenomics. Nutrigenomics is the study of the effects of food or food components on gene expression and how individual genetic differences can affect the way we respond to foods or nutrients. Need to know more? The CDC provides information through the Public Health Genomics and Precision Health Knowledge Base (v7.0) https://phgkb.cdc.gov/PHGKB/phgHome.action?action=home

Strategy Tip

Anybody can post anything on the Internet—and very little information is removed. To determine if the site you've chosen for information is accurate, reliable, and timely, get in the habit of evaluating websites and teaching your clients to evaluate them. Need help? Learn how to do it from a reliable source: https://guides.library.cornell.edu/evaluating_Web_pages>

Peer-Reviewed Literature and Evidence-Based Practice

Finding Peer-Reviewed Literature

Peer-reviewed literature Literature, including nutrition literature, that has been subjected to scholarly review by experts in the field and revision by the author to address any comments or concerns of these scholars prior to publication in a scientific journal or textbook.

Peer-reviewed literature is the *gold standard* for scientific information provided to the public as well as the information used for setting recommendations and policies, designing and evaluating nutrition programs, and conducting ethical evidence-based nutrition and dietetics practice. Unfortunately, the literature can be difficult to understand and results from different studies can be contradictory. Use of different study designs, populations, or methods—including statistical analyses—contribute to the confusion.

Assessing the science behind the policies, programs, practice, and consumer information begins with asking a question and finding, reading, and evaluating the articles needed to answer it. **PubMed** is the premiere database for articles on nutrition topics. This database is composed of more than 19 million citations for biomedical articles from MEDLINE and life science journals. Many citations in PubMed include links to full-text articles from PubMed Central or publisher websites. Important databases for nutrition-related research are shown in **Table 1–1**.

PubMed The premiere database for peer-reviewed articles on nutrition and medicine. Many citations in PubMed include links to full-text articles from PubMed Central or publisher websites.

TABLE 1–1
Databases Important for Nutritional Sciences Literature Searches

Database	Purpose
AGRICOLA AGRICultural OnLine Access	Provides citations in agriculture and related fields; produced by the National Agricultural Library (NAL).
AGRIS International System for Agricultural Science and Technology	International information system for the agricultural sciences and technology; created by the Food and Agriculture Organization of the United Nations (FAO).
BRFSS Behavioral Risk Factor Surveillance System: Survey Data	Includes eight databases on specific illnesses or aspects of chronic disease prevention and health promotion; designed to help public health professionals and educators locate program information. Managed by the Centers for Disease Control and Prevention (CDC)
CARIS Current Agricultural Research Information System	Created by FAO to identify and facilitate the exchange of information about current agricultural research projects being carried out by or on behalf of developing countries.
The Cochrane Library	Contains reliable evidence from Cochrane and other systematic reviews, clinical trials, and more. Cochrane reviews bring you the combined results of the world's best medical research studies and are recognized as the gold standard in evidence-based health care.
Directory of Open Access Journals	This database increases the visibility and ease of use of open access journals and promotes their increased usage and impact.
Embase	The trusted resource for the most comprehensive biomedical information.
ERIC Educational Resources Information Center	Includes educational research and resources; early childhood education, junior colleges and higher education; reading and communications skills; languages and linguistics; education management; counseling and personnel services; library and information science; information resources. Sponsored by the Institute of Education Sciences.
Food Safety Research Database	The Food Safety Research Information Office is located at the NAL. This office provides information on publicly funded, and to the extent possible, privately funded food safety research initiatives to prevent unintended duplication of food safety research and to assist the executive and legislative branches of the government and private research entities to assess food safety research needs and priorities.
FSTA Food Science and Technology Abstracts	The largest collection of food science, food technology, and food-related human nutrition abstracts. It contains over 1.5 million records with approximately 1,700 new entries added every week. FSTA covers journal articles as well as patents, theses, standards, legislation, books, reviews, and conference proceedings.
Health Source: Nursing/Academic Edition	Provides 260 scholarly full text journals, including nearly 120 peer-reviewed journals focusing on many medical disciplines. Also features abstracts and indexing for 930 journals.
Index to Scientific and Technical Proceedings	Indexes the published literature of the most significant conferences, symposia, seminars, colloquia, workshops, and conventions in a wide range of disciplines in science and technology over the last 5 years.
LILACS Latin American and Caribbean on Health Sciences Literature	Comprehensive database of Latin America and Caribbean with more than 880,000 records of peer-reviewed journals, thesis and dissertations, government documents, annals of congresses and books; sponsored and managed by BIREME through the Pan American Health Organization (PAHO)

(continues)

TABLE 1–1
Databases Important for Nutritional Sciences Literature Searches *(continued)*

Database	Purpose
MEDLINE	Sponsored by the National Library of Medicine, contains citations and abstracts to international biomedical literature from over 5,200 journals on subjects in biomedicine and health used in research and clinical care, public health, health policy development, or related educational activities.
Merck Index Online	Highly authoritative, full test database of information on chemicals, drugs, and biologicals; contains over 11,500 monographs. Sponsored online by the Royal Society of Chemistry.
Nursing and Allied Health Premium	Contains over 700 scholarly journals and 360 full-length clinical skills videos to support the teaching, learning, and research needs of nursing and allied health students and educators. Developed by Proquest, formerly the Nursing and Allied Health Database.
Science Direct	Database of more than 2,500 journals and 39,000 books in scientific, technical, and medical research, including 370 full open-access publications. Offered through Elsevier.
Scopus®	The largest abstract and citation base of peer-reviewed literature.
Web of Science (Science Citation Index Expanded)	Indexes over 9,200 major journals across 178 scientific disciplines.

If your library does not have access to these databases, just ask the librarian at your college or university to help you.

Strategy Tip

Not familiar with PubMed? Work through the online tutorials to help with your literature searches (https://learn.nlm.nih.gov/documentation/training-packets/T0042010P/) or ask your college or university librarian to help you.

Assessing Article Quality

After asking a question and determining the appropriate database to use, the next stage is selecting the descriptors and conducting the search. The descriptors and the search limits depend on the question(s) you are asking. For example, if your question is, "What is the effect of 100% fruit juice consumption on weight in children?" your descriptors could be "fruit juice" OR "fruit" AND "weight" OR "BMI" AND "children" OR "adolescents." The search might be easier if your search limit is "All Children," in which case the last two descriptors could be eliminated. Scanning the titles and abstracts will allow you to determine which articles are appropriate to answer your question. Obtaining the full-text articles, either by downloading them or visiting the library, and assessing them are the next steps (**Table 1–2**). This is not casual reading to prepare a summary

TABLE 1–2
How to Assess an Article from the Peer-Reviewed Literature

Title

1. Did the title reflect what was actually done in the study? The purpose, the populations used, the findings, and conclusions can be reflected in the title. A positive statement about the contents rather than a title that is a question is preferred.

Abstract

1. Did the abstract clearly outline all aspects of the manuscript?
   a. The purpose of the study
   b. The methods
   c. The results
   d. The conclusions
2. Was enough information provided to understand what was done and what was found?

Introduction

1. Did the authors provide enough background information to understand why the study was done?
2. Did the authors provide enough background information to let you know what others have done on this topic and where there might be gaps in the literature?*
3. Were important studies omitted from the introduction? This might suggest bias.
4. Did the authors clearly state the purpose of the study? A hypothesis or research question should have been stated. Not all study designs are appropriate for testing hypotheses; for example, cross-sectional studies are hypothesis generating.

Materials and Methods (could be referred to as Subjects and Methods)

1. Was the type of study clearly defined?
2. Did the experimental design allow the research question or hypotheses to be tested?
3. If appropriate, was a control group included? Was it comparable to the test group?
4. Was the population appropriate for the study?
5. Was the population suitable to generalize results?
6. Was the population well defined?
   a. Number/adequate sample size for appropriate statistical power
   b. Gender, age, race/ethnicity, income, etc.
   c. Inclusion/exclusion criteria for the study
   d. If the study population was a subset of a larger population, was it clear how the study population differed from the larger population? This could indicate bias.
   e. Was a convenience sample used or were the participants randomized?
7. Were there ethical concerns if human subjects or vertebrate animals were used? Was there a clear statement that the research has been approved by the appropriate committee?
8. Were the methods presented in enough detail so that the research could be repeated (or built upon) by another research team?
9. Were the methods used reliable and valid?
10. Statistical methods:
    a. Were they appropriate?
    b. Were outcome variables clearly defined?
    c. Did the authors control for potential confounding variables?
    d. Was a statistical probability level clearly stated?
11. Was it clearly stated how the data will be presented in the results (e.g., data are presented as mean ± standard error [SE])?
12. Were all terms defined?

Results

This section should present study results only. No methodology should be presented and unless it is a combined Results and Discussion section; there should be no interpretation of the information.

1. Were results organized in a logical sequence?
   a. Did the results follow the same order as the methods?
2. Were demographics presented?
3. Were the graphics appropriate?
   a. Were they needed? Should more or less be included?
   b. Was the information clearly presented in labeled tables and figures? Can the tables and figures stand alone?
   c. From a biological standpoint, were the data reasonable?

Discussion

1. Were the study objectives met?
2. Did the authors adequately interpret their results?
3. Did the authors discuss their results and compare them with the current literature?
4. Was the discussion related directly to the results or was it overly speculative?
5. If nonstandard methods were used, were they adequately discussed?
6. Were limitations of the study clearly stated?
7. Were conclusions drawn? Were they supported by the results?

References

1. Were appropriate citations listed? Were they accurate? Were they timely?
2. Were enough references presented so that a cogent whole presentation was in the manuscript?

Acknowledgments

1. Were the funding sources clearly identified?
2. Were there real or apparent conflicts of interest that could suggest bias?

*This is difficult for those unfamiliar with the literature but becomes easier with practice and familiarity with the topic.

of the article but a critical evaluation of the published study—try it out with a subject you're interested in. However, a single peer-reviewed article is not sufficient to make ethical evidence-based practice decisions; setting public health goals (e.g., Healthy People [HP] 2030); developing dietary recommendations, (e.g., Dietary Reference Intakes [DRI]); mandating nutrition policy (e.g., Dietary Guidelines for Americans [DGA]); or designing nutrition programs for health professionals and the public (e.g., the Produce for Better Health Foundation's Have A Plant®). To do this, the strength of a body of scientific studies must be assessed.

The Agency for Healthcare Research and Quality, through its Evidence-Based Practice Centers, sponsors the development of evidence reports and

technology assessments to assist public- and private-sector organizations in their efforts to improve the quality of health care in the United States.[30-32] There are three important domains that should be addressed to grade the strength of the evidence: 1) the quality of the studies—including the extent to which bias was minimized, 2) the quantity of the studies—including the magnitude of effect, the number of studies conducted, and the sample size or power of the study, and 3) the consistency of results—whether similar studies produce similar results.

Another critical consideration when assessing the body of evidence is the study design: what type of study was used to produce the test results, and what was the relevance to the disease/condition/program under study? Some study designs are more powerful than others in providing evidence on a topic; this has given rise to the concept of a "**hierarchy of evidence**"[33] about the effectiveness of interventions, treatments, practice protocols, or policies. From bottom (least convincing) to top (best evidence), the hierarchy is generally presented as: expert opinion, case reports, case series, case-control studies; **cross-sectional** surveys; **cohort studies** (prospective or retrospective); **randomized controlled trials (RCT)**; and systematic reviews of RCT with or without meta-analysis. It should be kept in mind; however, that this hierarchy assumes that all studies were well designed and executed. A poor RCT may not provide the same level of evidence as a very well-designed, cross-sectional survey.

To assess a body of evidence, many organizations, including the National Heart, Lung, and Blood Institute (NHLBI), the Academy of Nutrition and Dietetics (the Academy), and the American Diabetes Association, have grading scales. The NHLBI uses a four-point scale to grade the scientific evidence from different study types (**Table 1–3**). The **Evidence Analysis Library (EAL)** of the Academy uses a five-step process; the fourth of which is to summarize evidence and the last is to develop a conclusion statement and assign a grade.

For the Academy's EAL, the scoring system is somewhat different. The Academy uses Grades I, II, III, IV, and V for good/strong, fair, limited/weak, expert opinion only, and not assignable, respectively.[31] Examples of evidence statements for a wide variety of nutrition-related topics are found on the EAL's website, including: Adult Weight Management, Bariatric Surgery, Fruit Juice, Heart Failure, Hypertension, Physical Activity, and Sodium. Keep in mind with all types of evidence reviews that they are time-consuming and new studies are continually being published. Be sure the information you use in your evidence review and your practice is the most recently available.

In addition to the EAL, the U.S. Department of Agriculture's (USDA) Nutrition Evidence Systematic Review (NESR) conducts systematic reviews to inform nutrition policy and programs, including the Dietary Guidelines for Americans. The process by which the NESR evaluates a body of literature on a given topic is similar to that of the EAL. The process used by the NESR is: Recruit expert workgroup, formulate evidence analysis questions, and conduct literature review for each question, Extract evidence and critically appraise each study, synthesize the evidence, and develop and grade a conclusion statement (https://nesr.usda.gov/).

Nutrition Monitoring

Collecting nutrition and health-related information from a population is critical for designing and evaluating policies and programs that improve health status and decrease risk factors. Scientists analyze data from **nutrition monitoring** programs and use these analyses to contribute to the literature.

Hierarchy of evidence Reflects the relative weight of different types of studies when making decisions about evidence based practice or clinical interventions. There is no single accepted version of the hierarchy of evidence, but there is general agreement that systematic reviews and meta-analyses rank the highest, followed by randomized controlled trials, cohort studies, and expert opinions and anecdotal experience ranks at the bottom.

Cross-sectional studies A type of observational study that involves collection and analysis of data from a population at one point in time. The National Health and Nutrition Examination Survey is an example of a cross-sectional study. These studies are used to generate hypotheses, not to test them.

Cohort studies A study design where populations (called cohorts) are followed prospectively or retrospectively with status evaluations for a disease or other outcome to determine which risk factors are associated with that outcome.

Randomized controlled trials A type of scientific study design in which the individuals being studied are randomly assigned to different treatments under study. The most rigorous of these trials is a double-blind, placebo-controlled trial, in which neither the investigator nor the study participant knows the treatment type. Results from these studies provide strong evidence in the hierarchy of evidence. This study design allows for testing of hypotheses.

Evidence Analysis Library A web-based site that provides the best available nutrition evidence on a variety of topics. Sponsored by the Academy of Nutrition and Dietetics, full access is free to Academy members.

Nutrition monitoring Collecting nutrition and health-related information from a population is critical for designing and evaluating policies and programs that improve health status and decrease risk factors.

TABLE 1–3
National Heart, Lung, and Blood Institute's Evidence Categories

Category	Sources of Evidence	Definition
Category A	Randomized controlled trials (rich body of data)	Well-designed, randomized clinical trials that provide a consistent pattern of findings in the population for which the recommendation is made. Category A requires substantial numbers of studies involving substantial numbers of participants.
Category B	Randomized controlled trials (limited body of data)	Limited randomized trials or interventions, post-hoc subgroup analyses, or meta-analyses of randomized clinical trials. These are used when there are a limited number of existing trials, study populations are small or provide inconsistent results, or when the trials were undertaken in a population that differs from the target population of recommendation.
Category C	Observational or nonrandomized studies	Evidence is from outcomes of uncontrolled or nonrandomized trials or from observational studies.
Category D	Panel Consensus Judgment	Expert judgment is based on the panel's synthesis of evidence from experimental research described in the literature or derived from the consensus of panel members based on clinical experience or knowledge that does not meet the above criteria. This category is used only where the provision of some guidance was deemed valuable but an adequately compelling clinical literature addressing the subject of the recommendation was deemed insufficient to place in one of the other categories.

National Institutes of Health. National Heart, Lung, and Blood Institute. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report (Appendices). Accessed January 31, 2021. Available at https://learn.nlm.nih.gov/documentation/training-packets/T0042010P

To be useful, information must be collected in a timely manner and presented to scientists, policymakers, and the public in a readily understandable form. Without current monitoring, decisions may be made using insufficient information or incorrect assumptions. Nutrition and health-related information can be obtained using several methods, notably through nutrition screening, assessment, and surveillance; these are often collectively referred to as nutrition monitoring.

Nutrition Screening and Assessment

Nutrition screening is a systematic approach to quickly identify nutrition problems or individuals at nutritional risk that are in need of further assessment or an intervention. Screening can be done in free-living and hospitalized individuals; however, it is important to use validated instruments to maximize the chance of correctly identifying at-risk individuals.[34,35] The mini-nutritional assessment, used in screening elderly populations[36] is a widely used, valid screening instrument. Many other screening tools are available for nutrition professionals, including those designed to determine malnutrition,[37] diabetes risk,[38] and food security.[39]

Nutrition assessment collects, verifies, and interprets data used to identify nutrition-related problems and includes nutrition-related history, anthropometric measures, biochemical data, nutrition-focused physical findings, and social and medical history. This can be gathered on a population or individual level and various methods are used to collect these data.[40] To assess nutrition-related history, especially nutrition intake, community and public health, dietitians/nutritionists use such methods as 24-hour diet recalls, food frequency questionnaires (FFQs), food records (or diaries), food and nutrient screeners (also called short dietary assessments),[41] or newer technology-based dietary assessment tools such as web-based programs, mobile applications, or image-based tools.[42,43]

The 24-hour diet recall is used to capture short-term diet information about a group of people. Principal strengths of 24-hour diet recalls are

Strategy Tip

The Academy of Nutrition and Dietetics (the Academy) members have full online access to the Evidence Analysis Library at https://www.andeal.org. Members can also download the Evidence Analysis Manual.

Strategy Tip

Stay on top of nutritional monitoring and other events in public health by subscribing online to the *Morbidity and Mortality Weekly Report* at http://www.cdc.gov/mmwr/mmwrsubscribe.html

Center for Nutrition Policy and Promotion The center within the U.S. Department of Agriculture (USDA) where scientific research is linked to the nutritional needs of the American public. Projects include, but are not limited to: the Dietary Guidelines of Americans, MyPlate, the Healthy Eating Index, the USDA Food Patterns, and the USDA Food Plans: Cost of Food.

that they provide detailed information about the types and amounts of food consumed on a given day, have a low response burden, and are cost-effective.[41] The principal limitations are that they rely on specific memory, respondents may under- or over-report consumption, and need multiple nonconsecutive recalls in order to estimate usual dietary intake. Additionally, 24-hour diet recalls are not valid for individuals; collection of group data from 24-hour diet recalls with mean reporting, for example, as used by What We Eat in America, the dietary component of the NHANES, is an appropriate use of 24-hour diet recalls;[44] however, it has long been recognized that 24-hour diet recalls may not reflect usual intake.[41] In 2003, staff members of NHANES began collecting two recalls, the first in person in the Mobile Examination Center and the second 3 to 10 days later by telephone. The National Cancer Institute (NCI), coupled with the **Center for Nutrition Policy and Promotion (CNPP)**, developed a statistical method to calculate usual intake using both recalls.[45] The multiple-pass method for the 24-hour dietary recalls[46] should be used to avoid underreporting of intake (**Table 1–4**). The standard for assessing intake is multiple

TABLE 1–4
Information Collected During National Health and Nutrition Examination Survey Diet Interviews

5-Step Multiple-Pass Approach

Step	*Purpose*
Quick List	Collect a list of foods and beverages consumed the previous day.
Forgotten Foods	Probe for foods forgotten during the Quick List.
Time & Occasion	Collect time and eating occasion for each food.
Detail Cycle	For each food, collect detailed description, amount, and additions. Review 24-hour day.
Final Probe	Final probe for anything else consumed.

For each food and beverage consumed during previous 24-hour period	Detailed description
	Additions to the food
	Amount consumed
	What foods were eaten in combination
	Time eating occasion began
	Name of eating occasion
	Food source (where obtained)
	Whether food was eaten at home
	Amounts of food energy and 60+ nutrients/food components provided by the amount of food (calculated)
For each respondent on each day	Day of the week
	Amount and type of water consumed, including total plain water, tap water, and plain carbonated water
	Source of tap water Daily intake usual, much more or much less than usual
	Use and type of salt at table and in preparation
	Whether on a special diet and type of diet
	Frequency of fish and shellfish consumption (past 30 days)
	Daily total intakes of food energy and 60+ nutrients/food components (calculated)

U.S. Department of Agriculture. Accessed January 31, 2021. Retrieved from https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/ampm-usda-automated-multiple-pass-method

24-hour dietary recalls using the multiple-pass method. Intake can change from weekday to weekend, from season to season, and between holiday and nonholiday days; it is important to get a proper sample of the study group using 24-hour diet recalls at different times of the week and year to better capture these differences. The NCI's Dietary Assessment Primer contains recommendations for data capture for 24-hour diet recalls, in addition to other dietary assessment tools.[41]

It should also be noted that NHANES collects information on supplement and prescription medication intake, food security, some consumer behaviors, as well as anthropometrics. These data can be used with the data collected from the recalls not only to further the nutrition assessment but also to look for associations among variables.

Food Frequency Questionnaires (FFQs), in contrast to 24-hour diet recalls or food records, are designed to measure dietary intake over longer periods. FFQs vary in the number of food items, food groups, and food portion assessments—all of which affect nutrient intake.[41] Similar to 24-hour diet recalls, FFQs often underestimate intake of total energy, and energy adjustment can be used to reduce the effects of measurement error, that is, regression dilution. It is also important that appropriate racial and ethnic foods consumed by the targeted population be included when designing FFQ. Although a wide variety of FFQs are in use, some have not been validated against 24-hour recalls or direct observation. Using meta-analyses, FFQs with longer food lists (200 items) were shown to have 0.01 to 0.17 higher correlation coefficients than FFQs with shorter food lists (<100 items) for most nutrients.[47] An advantage of FFQs is that they can be self-administered and thus are suitable for large epidemiologic studies.

Newer methods of dietary intake measurement include digital photography entered by either a researcher or self-recording from a mobile application.[42] An example is the Remote Food Photography Method, which uses a smartphone to capture images of food selection and plate waste, which are sent to a server for intake estimation.[48] These digital photography methods are appealing because they use technology, but accuracy is dependent on training staff, study participants, or clients to take consistent photographs. Other methods used to determine intake include direct observation, plate waste, and food records with or without weighing foods.

Determining intake accurately is critical. Intake of food groups can be determined from using instruments as conventional as the *Start Simple with MyPlate* app[49], which is appropriate for the public, and the Food Patterns Equivalents Database,[50] which may be more appropriate for health professionals. Nutrient intake can be assessed using the USDA FoodData Central,[51] the Food and Nutrient Database for Dietary Studies,[52] and commercially available diet analysis programs. Different databases may not yield the same nutrient analyses and it is best to be consistent when using them to analyze data. Whenever possible, dietary intake should be confirmed using appropriate biomarkers; for example, folate intake should be confirmed with serum folate levels.[41] Intake of nutrients or food groups can be compared with recommended values for specific populations and, in turn, with the prevalence or incidence of chronic disease.

Population Surveillance

Surveillance comes from the French verb *surveiller*, "to watch over." In 1968, the World Health Assembly described surveillance as "the systematic collection and use of epidemiologic information for planning, implementation, and assessment of disease control."[53] Surveillance, in contrast to surveys, is

continual, and data that are collected can be used to provide the framework for public health policies and rationale for intervention. Surveillance also provides a way to monitor the effectiveness of specific interventions. This completes the loop—surveillance studies that can be used to determine nutritional problems or nutritional needs, and after the intervention, they can be used to determine whether the problems remain or if the intervention was effective.

Most governments track the health and nutrition status of their population. For example, the U.S. government has tracked information on food and the food supply for more than 100 years, starting with the USDA's Food Supply Series in 1909.[54] In 1936–1937, the USDA conducted the first national survey, known as the Consumer Purchases Study, to measure distribution of food at the household and individual level and conducted follow-up surveys at roughly 10-year intervals. The 1955 Household Food Consumption Survey (later called the Nationwide Food Consumption Survey (in 1977)) was the first nationally representative survey to cover all four seasons of food intake.[55,56] Health status was initially tracked separately from nutrition; in 1960, the National Health Examination Survey was initiated[57] however, it did not include information on nutrition and its link with diet. Federal officials thus could not provide information on diet and disease or undernutrition to Congress. The nation's largest nutrition survey to date was the Ten-State Nutrition Survey conducted between 1968 and 1970 in 10 states: California, Kentucky, Louisiana, Massachusetts, Michigan, New York, South Carolina, Texas, Washington, and West Virginia; however, the data collected and analyzed were not a nationally representative sample.[58] The NHANES I and II and the Pediatric Nutrition Surveillance Systems were initiated in the 1970s.[57,59]

National Nutrition Monitoring and Related Research Program
Established in 1990 (PL 101-445), this is a comprehensive, coordinated program for nutrition monitoring and related research to improve health and nutrition assessment in U.S. populations.

In 1990, the **National Nutrition Monitoring and Related Research Program (NNMRRP)** (Public Law [PL] 101-445) established a comprehensive, coordinated program for nutrition monitoring and related research to improve health and nutrition assessment in U.S. populations.[60] The NNMRRP required a program to coordinate federal nutrition monitoring efforts and assisted state and local governments in participating in a nutrition monitoring network; an interagency board to develop and implement the program; and a nine-member advisory council to provide scientific and technical advice and to evaluate program effectiveness. The NNMRRP also required that dietary guidelines (DGA) be issued every 5 years, and that any dietary guidance issued by the federal government for the general public be reviewed by the Secretaries of Agriculture and Health and Human Services (HHS).

Goals of NHANES

- Estimate the number and percentage of persons in the U.S. population, and designated subgroups, with selected diseases and risk factors
- Monitor trends in the prevalence, awareness, treatment, and control of selected diseases
- Monitor trends in risk behaviors and environmental exposures
- Analyze risk factors for selected diseases
- Study the relationship between diet, nutrition, and health
- Explore emerging public health issues and new technologies
- Establish a national probability sample of genetic material for future genetic research
- Establish and maintain a national probability sample of baseline information on health and nutritional status

The NNMRRP encompasses more than 50 surveillance activities that monitor and assess health and nutritional status in the United States. Monitoring efforts are divided into five overarching areas: nutrition and related health measurements; food and nutrient consumption; knowledge, attitude, and behavior assessments; food composition and nutrient databases; and food supply determinants. Important monitoring programs are summarized in **Table 1–5**. Most of the data sets generated through this program are available to the public. Some are restricted, due to confidential or disclosure rules/regulations, and can be accessed by researchers through application to the Research Data Center in the National Center for Health Statistics (NCHS) headquarters in Hyattsville, Maryland.

In 2002, the Department of HHS and the USDA integrated NHANES and the Continuing Survey of Food Intakes by Individuals (CSFII), the two major diet and health surveys, into a continuous data collection system. Diet and nutrition information thus can be linked directly to health status information. The integrated dietary component of the NHANES is titled, "*What We Eat in America.*"[61]

TABLE 1–5
National Nutrition-Related Health Assessments[a]

Survey Name	Date	Target	Data Collected	Dept/Agency
Nutritional and Related Health Measurements				
NHANES[b]	1999–present	Civilian, noninstitutionalized persons 2 months or older; oversampling of adolescents, African-Americans, Mexican-Americans, and adults >60 years of age	Survey elements are similar to NHANES III & NHIS.[c] This is a continuous monitoring system.	NCHS, CDC (HHS)
NHANES III	1988–1994	Civilian, noninstitutionalized persons 2 months or older; oversampling of adolescents, non-Hispanic blacks, Mexican-Americans, children, 6 years and adults >60 years of age	Demographics, dietary intake (24-hour recall and food frequency), biochemical analysis of blood and urine, physical examination, anthropometry, blood pressure, bone densitometry, diet and health behaviors, health conditions	NCHS, CDC (HHS)
NHANES III Supplemental Nutrition Survey of Older Persons	1988–1994	Representative U.S. elderly population	See above	NCHS, NIH/NIA
HHANES	1982–1984	Civilian, noninstitutionalized Mexican Americans in five southwestern states, Cuban Americans in Dade Co., FL, and Puerto Ricans in New York, New Jersey, and Connecticut, 6 months to 74 years of age	Demographics, dietary intake (24-hour recall & food frequency), biochemical analysis of blood and urine, physical exam, anthropometry, blood pressure, diet and health behaviors, health conditions	NCHS (HHS)
NHANES II	1976–1980	Civilian, noninstitutionalized persons 6 months to 74 years of age	Demographics, dietary intake, biochemical analysis of blood and urine, physical exam, anthropometry	NCHS (HHS)
NHANES I	1971–1974	Civilian, noninstitutionalized population of the conterminous states 1 to 74 years of age	Demographics, dietary information, biochemical analysis of blood and urine, physical exam, anthropometry	NCHS (HHS)
Food and Nutrient Consumption				
CSFII[d]	1994–1996 1989–1991 1985–1986	Individuals of all ages with oversampling in low-income households	One- and 3-day food intakes, times of eating events, sources of food eaten away from home	ARS, HNIS
TDS	1961, annual	Specific age and gender groups	Determines levels of nutrients and contaminants in the food supply—analyses are performed on foods that are "table-ready"	FDA (HHS)
Consumer Expenditure Survey	1980, continuous	Noninstitutionalized population and a portion of the institutionalized population in the United States	Demographics, food stamp use, average annual food expenditures	U.S. Bureau of Labor Statistics
NFCS	1987 1977–1978	Households in the conterminous states—all income and low income	Households: quantity (pounds), money value (dollars), and nutritive value of food eaten. Individuals: food intake, times of eating events, and sources of foods eaten away from home	HNIS (USDA) ARS (USDA)

(continues)

TABLE 1–5
National Nutrition-Related Health Assessments[a] *(continued)*

Survey Name	Date	Target	Data Collected	Dept/Agency
Food and Nutrient Consumption				
SNDA II	1998	Public schools in the 48 contiguous states and the District of Columbia that participate in the National School Lunch Program	School and food service characteristics, nutrients by food group and relationship to the RDA and DGA by meals, source of meals, and nutrient content of USDA meals	FNS/USDA
WIC Infant Feeding Practices Study	1994–1995	Pre- and postnatal women and their children who participate in WIC	Demographics, rates of breast and formula feeding, factors associated with breast feeding.	FNS/USDA
Knowledge, Attitude, and Behavior Assessments				
DHKS	1994–1996	Adults 20 years and older who participated in CSFII 1994–1996	Demographics, self-perceptions of relative intake, awareness of diet and health relationships, food-label use, perceived importance of following diet and health recommendations, beliefs about food safety, and knowledge of sources of nutrients; data can be linked with intake through CSFII data	ARS/USDA
Infant Feeding Practices Survey	1993–1994	New mothers and healthy infants to 1 year of age	Demographics, prior infant feeding practices, baby's social situation, characteristics associated with breastfeeding, development of allergies	FDA
Consumer Food Handling Practices and Awareness of Microbiological Hazards	1998 1992–1993	Civilian, noninstitutionalized over 18 years with telephones	Demographics, prevalence of unsafe food handling practices, knowledge of food safety principles, use of sources of information about safe food handling, incidence of foodborne illnesses	FDA
Food Composition and Nutrient Databases				
National Nutrient Data Bank[e]	–	–	This is the repository for values of approximately 7,100 foods and up to 80 components. Essentially all food composition databases are derived from this data bank	ARS (USDA)
Food Label and Package Survey	1977–1996, biennially 2000, 2006	All brands of processed foods regulated by the FDA	Prevalence of nutrition labeling, declaration of select nutrients, prevalence of label claims and other descriptors	FDA (HHS)
Food Supply Determinations				
AC Nielsen SCANTRACK	1985, monthly	~3,000 U.S. Supermarkets	Sales and physical volume of specific market items, selling price, percent of stores selling the product	ERS/USDA
U.S. Food and Nutrient Supply Series	1909, annually	U.S. Population	ERS = Amount of food commodities that disappear into the food distribution system; CNPP = nutrient levels of food supply. Results are totaled for each nutrient and converted to per-day basis.	ERS/CNPP/USDA

Nutrition Monitoring Activities in the States				
PedNSS	1973, continuous	Low-income, high-risk children, birth to 17 years, emphasis on birth to 5 years	Demographics, anthropometry, birth weight, hematology	NCCDPHP, CDC (HHS)
PNSS	1973, continuous	Convenience sample of low-income, high-risk pregnant women	Demographics, pregravid weight and maternal weight gain, anemia, behavioral risk factors, birth weight, and formula-feeding data	NCCDPHP, CDC (HHS)
YRBBS	Biennial	Civilian, noninstitutionalized adolescents 12 to 18 years	Demographics, diet and weight; drug, alcohol & tobacco use; seat belt and bicycle helmet use; behaviors that contribute to violence; suicidal tendencies[f]	CDC (HHS)/ NCCDPHP
BRFSS	1984, continuous	Adults 18 years and older in households with telephones located in participating states	Demographics, questions that assess risk factors associated with leading causes of death: alcohol and tobacco use, weight, seat belt and helmet use; use of preventative medical care[g]	CDC (HHS)/ NCCDPHP

[a]A complete guide to nutrition monitoring in the United States can be found at: http://www.cdc.gov/nchs/data/misc/nutri98.pdf
[b]Abbreviations: ARS = Agricultural Research Service; BRFSS = Behavioral Risk Factor Surveillance System; CDC = Centers for Disease Control and Prevention; CNPP = Center for Nutrition Policy and Promotion; CSFII = Continuing Survey of Food Intakes by Individuals; DHKS = Diet and Health Knowledge Survey; ERS = Economic Research Service FDA = Food and Drug Administration; HHANES = Hispanic Health and Nutrition Examination Survey; HHS = Health and Human Services; HNIS = Human Nutrition Information Service; NFCS = Nationwide Food Consumption Survey; NCCDPHP = National Center for Chronic Disease Prevention and Health Promotion; NCHS = National Center for Health Statistics; NCI = National Cancer Institute; NHANES = National Health and Nutrition Examination Survey; NHIS = National Health Interview Survey; NIA = National Institute on Aging; NIH= National Institutes of Health; PedNSS = Pediatric Nutrition Surveillance System; PNSS = Pregnancy Nutrition Surveillance System; SNDA = School Nutrition Dietary Assessment Study; TDS = Total Diet Study; USDA = U.S. Department of Agriculture; WIC = Women, Infants, and Children; YRBSS = Youth Risk Behavioral Surveillance System.
[c]http://www.cdc.gov/nchs/data/nhanes/survey_content_99_16.pdf complete survey content of NHANES 1999–2016
[d]CSFII and NHANES were combined into a single survey
[e]Now FoodData Central on the USDA website: https://fdc.nal.usda.gov/
[f]https://www.cdc.gov/healthyyouth/data/yrbs/results.htm - YBRSS report 2019, reports available through CDC Web site
[g]https://www.cdc.gov/brfss/about/index.htm - Behavioral Risk Factor Surveillance System full information

The National Health and Nutrition Examination Survey

The NHANES is a program of studies designed to assess the health and nutritional status of the U.S. population. The survey combines health interviews and physical examinations with dietary information (**Table 1–6**).

Beginning in 1999, the NHANES became a continuous surveillance program with data released to the public biannually. Rather than using a random sample, the NHANES uses a complex, multistage, probability sampling design to select participants representative of the civilian, noninstitutionalized U.S. population. Oversampling of certain population subgroups (i.e., Hispanic Americans, African Americans, and persons 60 and older) increases the reliability and precision of health status indicator estimates for these subgroups. Data collection by the NHANES occurs at three levels: a brief household screener interview, an in-depth household survey interview, and a medical examination. Because detailed interviews, clinical, laboratory, radiological examinations are conducted, the response burden to participants is significant. Interviews and medical examinations take place in a mobile examination center. Because of this sampling design, using appropriate statistical analyses of NHANES data are critical. To assure that NHANES analyses reflect a nationally representative sample, it is important to use the described weighting system and specialty software (e.g., SUDAAN. Stata).[62]

TABLE 1–6
Data Available Through NHANES

Health Exam Tests

Health Measurements by Participant Age and Gender

- Physician's exam—all ages
- Blood pressure—ages ≥8 years
- Bone density—ages ≥8 years
- Condition of teeth—ages ≥5 years
- Vision test—ages ≥12 years
- Hearing test—ages 12–19 and ≥70 years
- Height, weight, and other body measures—all ages
- Ophthalmology exam for eye diseases—ages ≥40 years
- Breathing tests—ages 6–79 years

Lab Tests on Urine (≥6 years)

- Kidney Function tests—ages ≥6 years
- Sexually transmitted diseases (STD), Chlamydia and gonorrhea—ages 14–39 years
- Exposure to environmental chemicals—selected persons ages ≥X years
- Pregnancy test—girls and women ages ≥12 years and girls ages 8–11 years who have periods

Lab Tests on Blood: (≥1 year and older)

- Anemia—all ages
- Total cholesterol and high-density lipoprotein (HDL) —ages ≥6 years
- Glucose measures—ages ≥12 years
- Infectious diseases—ages ≥2 years
- Kidney function tests—ages ≥12 years
- Lead—ages ≥1 years
- Cadmium—ages ≥1 years
- Mercury—ages ≥1 years
- Liver function tests—ages ≥12 years
- Nutrition status—ages ≥1 years
- Thyroid function test—ages ≥12 years
- Prostate-specific antigen (PSA) —men ages ≥40 years
- Sexually transmitted diseases (STD)
  - — Genital herpes—ages 14–49 years
  - — Human immunodeficiency virus (HIV) —ages 18–49 years
  - — Human papillomavirus (HPV) antibody—ages 14–59 years
- Exposure to environmental chemicals—selected persons ages ≥6 years

Lab Tests on Water

- Environmental chemicals—ages ≥12 years in half of households

Other Lab Tests

- Vaginal swabs (self-administered) —girls and women aged 14–59 years
- Human papillomavirus (HPV) —ages 14–59 years

Private Health Interviews

- Health status—ages ≥12 and older
- Questions about drug and alcohol use—ages ≥12 years (no drug testing will be done)
- Reproductive health—girls and women ages ≥12 years
- Questions about sexual experience—aged 14–69 years
- Tobacco use—ages ≥12 years

Anthropometry from the Mobile Examination Center

- Body mass index; for children ages 2–19 years; BMI z-score is also determined
- Waist circumference
- Skinfold measurements and body fat measures through DXA

Dietary Information from the Mobile Examination Center

- 24-hour dietary recalls; parents or guardians report for children 0–5 years of age; children 6–11 years are assisted by an adult; children ≥12 years self-report
- Food frequency questionnaire

After the Visit to the NHANES Examination Center

- Persons asked about the foods they eat will receive a phone call 3–10 days after their exam for a similar interview, all ages.
- Then participants, or an adult for participants 1–15 years old, are asked about food shopping habits.
- Persons who test positive for hepatitis C will be asked to participate in a brief telephone interview 6 months after the exam. Parents will respond for children.

It is difficult to quantify the tremendous impact that NHANES and related programs have had on health policy and health research in the United States.[63] One way to look at this is the number of publications generated using NHANES data. A PubMed search in February of 2021 using the term "NHANES" produced 53,993 publications on topics as diverse as the relationship between lean body mass indices, physical activity, and systolic blood pressure; income-related inequalities in untreated dental caries among young children; number of adults meeting prediabetes criteria; and the association between eating behavior and diet quality when eating alone vs. with others. NHANES data have also shown that there are ethnic/racial and income differences in dietary intake, including food sources for nutrients[64,65] control of cardiovascular risk factors vary according to socioeconomic status;[66] and hypertension morbidity is increased in U.S. immigrant groups but varies by race/ethnicity and gender.[67] These findings have important implications for intervention strategies.

Strategy Tip

Take a guided tour of the mobile examination center at https://www.cdc.gov/nchs/nhanes/participant/information-collected.htm

Study Designs and Uses

Epidemiologic Studies

In addition to the NCHS data, a number of long-term, primarily government funded epidemiologic studies on adults and children/adolescents have provided critical information used to guide the nation's health policies and federal programs. The Bogalusa Heart Study (BHS), the Framingham Heart Study (FHS), and the Coronary Artery Risk Development in Young Adults (CARDIA) are leading examples. Other important U.S. epidemiologic studies that have contributed to our knowledge of risk reduction and disease prevention are The Nurses' Health Study (NHS; N = 170,000 female registered nurses between the ages of 30 and 55 years at the beginning of the study) and the NHS II (NHS II established in 1989, N = ~117,000 female nurses aged between 25 and 42 years); and the all-men Health Professional Follow-up Study (initiated in 1986 with 2-year scheduled follow-ups), which was designed to complement the NHS, relating nutritional factors to the incidence of serious illnesses, such as cancer, heart disease, and other vascular diseases in 51,529 male health professionals. Also of import is the Iowa Women's Health Study with a cohort of 41,837 postmenopausal women who have been followed since 1985. These studies combined have produced more than 2,000 scientific publications and have helped shape medical care, risk reduction and health promotion, and public policy.

The Bogalusa Heart Study was extended and many findings were duplicated in another population through the Young Finns Study. To learn more about the Young Finns Study, go to https:/youngfinnsstudy.utu.fi

The Bogalusa Heart Study (BHS)

The BHS[68-70] was designed initially to examine the early natural history of coronary heart disease and essential hypertension in a biracial (black/white) pediatric population. The BHS population consists of approximately 5,000 individuals who have been studied at various growth phases and have been followed for as long as 15 years. The mixed epidemiologic design of the study has included cross-sectional and longitudinal surveys to provide information on three questions: 1) what are the distribution and prevalence of cardiovascular disease (CVD) risk factors in a defined pediatric population and how are abnormal serum lipid levels, blood pressure, and other risk factors defined in children; 2) do cardiovascular risk factors track and change over time; and 3) what is the interrelationship among these risk factors? Other questions, notably what is the interaction of genetics and the environment in CVD, were also posed.

Data from the BHS have contributed significantly to our knowledge and understanding of cardiovascular risk factors in children as well as the history of CVD in early life. For example, information on children, adolescents, and young adults from birth to 31 years of age has provided the framework to establish desirable cholesterol levels in children, and has led investigators to recommend screening of cardiovascular risk factors for all children, not only those with a parental history of heart disease or dyslipidemia, beginning at elementary school age.

Data have also suggested that risk factors for CVD "track," that is, they remain in a rank relative to peers over time. For example, children with elevated serum total cholesterol or low density lipoprotein cholesterol (LDL-C) levels are likely to become adults with dyslipidemia. Bogalusa Heart Study data have been used to characterize diets of children and secular trends in children's diets for more than 30 years.[71] BHS data were used as the rationale by the American Academy of Pediatrics for their recommendation that the DGA could apply to healthy children 2 years of age and older and to develop the Academy's original position paper on dietary guidance for healthy children 2 to 11 years of age.[72]

To learn more about working with NHANES data, complete the online tutorial at https://wwwn.cdc.gov/nchs/nhanes/tutorials/default.aspx

One of the major accomplishments of the BHS did not come from epidemiologic data per se, but from autopsy studies of participants,[73] usually those killed in accidents. Data from the BHS confirmed and extended earlier studies[74] that showed fatty streaks in the aorta were evident in the first decade of life and that the extent of these lesions was highly associated with serum total cholesterol and LDL-C levels. These findings provided the rationale for interventions that focused on healthy lifestyles for children.

Framingham Heart Study

The FHS has been described as "one of the most impressive medical works in the 20th century."[75] The Framingham Study has provided information critical to the recognition and management of atherosclerosis and its causes and complications. Initiated under the auspices of the National Heart Institute (now the NHLBI) in 1948, 1,980 males and 2,421 females were enrolled originally in a 3-year observational study in Framingham, Massachusetts, which at the time was a novel idea. Published in 1961, the first report, titled, "Factors of risk in the development of coronary heart disease—six-year follow-up experience; the Framingham Study," identified high blood pressure, smoking, and high cholesterol levels as major factors in heart disease and conceptualized them as risk factors.[76] Continued study of the population has provided health professionals with multifactorial risk profiles for cardiovascular disease that have assisted in identifying individuals at high risk as well as providing the basis for preventative measures. During its more than 70-year history, the FHS has introduced the concept of biologic, genomic, environmental, and behavioral risk factors; identified major risk factors associated with heart disease, stroke, and other diseases; revolutionized preventive medicine; and changed how the medical community and general population regard disease pathogenesis.[77] The National Cholesterol Education Program[78] uses the Framingham risk scoring system to determine the 10-year risk of CHD in adults. New findings from the FHS genomics measures are being used to study how modifiable lifestyle factors may affect the risk of chronic disease.[79]

In 1971, the Framingham Heart Offspring Study began,[80] consisting of 5,124 males and females, 5 to 70 years of age, who were offspring and spouses of the offspring of the original Framingham cohort. The objectives of that study were to determine the incidence and prevalence of CVD and its risk factors, trends in CVD incidence and its risk factors over time, and family

patterns of CVD and risk factors. The Offspring Study provided the opportunity to evaluate a second generation of participants, assess new or emerging risk factors and outcomes, and provide a resource for future genetic analyses. In 2020, funding was granted for the development of the FHS Brain Aging Program, which will evaluate FHS participants for dementia and incorporate data from the original and subsequent cohorts of the FHS to further conduct research into genetic and other factors involved with Alzheimer's disease and vascular dementia.[81]

The quality of data from surveys and epidemiologic studies depends on the training of personnel and adherence to rigid protocols. It also depends on the validity and reliability of the test instruments used as well as on the responses of the subjects. Instruments may need to be modified for specific populations. For example, in the BHS, the 24-hour diet recall method had to be adapted for use in children.[82,83] To improve the reliability and validity of the 24-hour diet recall, quality controls included the use of a standardized protocol that specified exact techniques for interviewing, recording, and calculating results; standardized graduated food models to quantify foods and beverages consumed; a product identification notebook for probing of snack consumption, and foods and beverages most commonly forgotten; school lunch assessment to identify all school lunch recipes, preparation methods, and average portion sizes of menu items reflected in each 24-hour diet recall; follow-up telephone calls to parents to obtain information on brand names, recipes, and preparation methods of meals served at home; products researched in the field to obtain updated information on ingredients and preparation, and their weights (primarily snack foods and fast foods).[84] All interviewers participated in rigorous training sessions and pilot studies before the field surveys to minimize interviewer effects. One 24-hour diet recall was collected on each study participant, and duplicate recalls were collected from a 10% random subsample to assess interviewer variability.

Metabolic Diet Studies

Metabolic diet studies are conducted in clinical research centers where study participants are randomized into test or control groups and are fed an experimental diet or "regular" diet, respectively. Different designs are available for metabolic diet studies,[85] but the one that provides the most valid results is a double-blind, placebo-controlled study. In these studies, neither the investigator nor the participant knows whether the test or control diet is offered. Because it is difficult and expensive to do these studies, they are usually short term and have a small sample size; compliance and drop-out rates are problems.

Dietary Approaches to Stop Hypertension (DASH)

The Dietary Approaches to Stop Hypertension (DASH)[86] and DASH sodium[87] trials are classic examples of metabolic diet studies. Epidemiologic, clinical trials, and studies using experimental animals showed that intake of some nutrients, notably low levels of sodium, and high levels of potassium and calcium lowered blood pressure; however, people eat food—not isolated nutrients. To test the impact that combination diets incorporating foods high in these nutrients had on blood pressure, the DASH study was conducted. DASH was a randomized controlled trial conducted at four academic medical centers with 459 adult participants. Inclusion criteria were untreated systolic blood pressure <160 mm Hg and diastolic blood pressure 80 to 95 mm Hg. For 3 weeks, participants ate a control diet. They were then randomized to 8 weeks of a control diet; a diet rich in fruits and vegetables; or a combination

diet rich in fruits, vegetables, and low-fat dairy foods, and low in saturated fatty acids, total fat, and cholesterol. Salt intake and weight were held constant, and diets were isoenergic. All food was prepared in a metabolic kitchen and was provided to participants. The combination diet (or "DASH diet") was shown to quickly (within 2 weeks) and substantially lower blood pressure.

In DASH sodium, a subsequent study, 412 participants were assigned to a control diet or a DASH diet; within the assigned diet, participants ate meals with high (3,450 mg/2,100 kcals), intermediate (2,300 mg/2,100 kcals), and low (1,150 mg/2,100 kcals) levels of sodium for 30 consecutive days each, in random order. Reduction of sodium intake to levels below the current recommendation of 100 mmol/day and the DASH diet substantially lowered blood pressure, with the most significant effect seen in lowering blood pressure with the lowest sodium concentration coupled with the DASH diet. The DASH diet has been widely embraced for the treatment of hypertension; nutrition education materials are readily available. As elegant and persuasive as the DASH studies were; one drawback to feeding studies is that participants receive all foods. Therefore, the studies cannot assess how compliant people are after the study ends. The PREMIER study[88] demonstrated that free-living individuals were able to make the lifestyle changes associated with decreased blood pressure.

Clinical Trials

Clinical trials are commonly used to determine the efficacy of drugs or other pharmacologic agents; however, they can also be used to assess diet or dietary interventions. They have many of the same advantages and disadvantages of metabolic studies. Because clinical trials of diet may involve pharmacologic intervention, they carry a risk that is not usually seen with metabolic diet studies. The classical example of this was seen in the Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study (ATBC Study)[89] and the Beta-Carotene and Retinol Efficacy Trial (CARET).[90] Based on epidemiologic data that showed a relationship between dietary intake of fruits and vegetables[91,92] or, specifically, of beta carotene[93] and a reduced risk of developing lung cancer, especially in smokers,[94] the ATBC and CARET studies used high doses of beta-carotene in major cancer chemopreventive trials. Investigators expected to see reductions in lung cancer by as much as 49% in some high-risk groups. In actuality, the opposite was seen and beta-carotene increased the risk of lung cancer, forcing the CARET study to be stopped early.[95] These studies clearly point to the necessity of additional research and have important public health implications.

Animal Studies

Animal studies are important in nutrition research for many reasons. Laboratory animals that are genetically identical and exposed to the same environmental conditions can be fed carefully characterized diets with different combinations of nutrients; thus, the number of variables studied are limited. Special treatments, such as genetic and metabolite alterations to mimic cognitive impairments,[96] can be performed on animals. Because the lifespan of most laboratory animals is short, the effects of dietary manipulation can be followed over several generations. Animals can be sacrificed at the end of the experiment and the effect of the treatment can be examined closely at the organ, tissue, or cellular level. Animal studies can explore molecular mechanisms behind a given observation in humans. For example, ferrets were used to determine that high doses of beta-carotene caused keratinized squamous metaplasia

in lung tissues that was exacerbated by exposure to cigarette smoke.[97] This explains the paradoxical relationship between beta-carotene and smoking that is seen in the clinical trials above. It points out another use of animal studies: that the metabolism of natural products should be investigated using animal models *before* beginning intervention trials, particularly if nutrient doses exceed recommended levels.[98]

Animals most commonly used in nutrition research are rats, mice, rabbits, guinea pigs, dogs, sheep, and monkeys. The species selected for a given experiment should be that which is the most similar to human metabolism for a particular nutrient. The importance of this is illustrated in the classic studies of vitamin C metabolism. Guinea pigs are the only laboratory animal that, like humans, have an obligatory requirement for this nutrient; thus, a review of the literature shows only guinea pigs were used for vitamin C research.

Many of the elements that make animal studies so appealing in nutrition research are also drawbacks. With the exception of monozygotic twins, humans are not genetically identical; thus, no matter how carefully a human experiment is controlled, responses to dietary manipulations may be different due to individual genetic backgrounds. Interactions between genetics and the environment are easy to study in animals, but results are difficult to translate to humans.

Community and Public Health Services

There are many programs and services run by the government that serve to create nutrition policies and help the public make healthier choices with regard to overall health and specifically nutrition. All of them draw from the wealth of information created by the surveys, studies, and surveillance systems that report on the health and nutrition status of the U.S. population. *Healthy People 2030* and the **Dietary Reference Intakes** create a framework to guide nutrition policy in the country. All other programs and services use that framework to communicate a unified message for health and nutrition for the nation. Examples of these programs and services include the Dietary Guidelines for Americans, **MyPlate**, the Healthy Eating Index, and food labels and health claims. Public health dietitians/nutritionists can leverage these programs and services in their work with the community.

Dietary Reference Intakes A system of nutrition recommendations from the Institute of Medicine's Food and Nutrition Board (now the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine). Introduced in 1997, the DRI's were developed to broaden the Recommended Dietary Allowances.

MyPlate Is the "visual translation" of the Dietary Guidelines for Americans for the public.

Healthy People 2030

Individual health is closely linked to community health—the health of the community and environment in which individuals live, work, and play. Community health, in turn, is profoundly affected by the collective beliefs, attitudes, and behaviors of everyone who lives in that community. *Healthy People 2030*, published by the Office of Disease Prevention and Health Promotion (OCPHP) in the Department of Health and Human Services (HHS),[99] is the set of public health priorities designed to guide the health and well-being of the nation; HP goals remain in place for 10 years; the next update will be HP2040. Each new HP iteration is created out of the knowledge gained from the previous decades; HP2030 is the 5th iteration based on the past 4 decades of information. In 1979, *Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention*[100] provided nutritional goals for reducing premature deaths and preserving independence for older adults. In 1980, *Promoting Health/Preventing Disease: Objectives for the Nation*, targeted 226 health objectives for the nation to achieve over the next 10-year period.[101] These were followed by HP 2000, 2010, 2020, and now 2030 goals.

The overarching goals for HP2030 are[99]

- Attain healthy, thriving lives and well-being free of preventable disease, disability, injury, and premature death
- Eliminate health disparities, achieve health equity, and attain health literacy to improve the health and well-being of all
- Create social, physical, and economic environments that promote attaining the full potential for health and well-being for all
- Promote health development, healthy behaviors, and well-being across all life stages
- Engage leadership, key constituents, and the public across multiple sectors to take action and design policies that improve the health and well-being of all

Healthy People 2030 Established by the Department of Health and Human Services, this is the comprehensive health promotion and disease prevention agenda for the nation.

Healthy People 2030 has 62 topic areas and tracks 355 core (or measureable) objectives. It also designates some objectives as developmental and research objectives, neither of which are measured in the HP2030 framework (though these objectives have the potential to become core objectives during the course of the decade as more research and data become available). Developmental objectives are high-priority public health issues with evidence-based interventions but lacking reliable baseline data whereas research objectives are public health issues with a high health or economic burden or with significant disparities in the population that do not yet have evidence-based interventions. This represents a change from HP2020, which had approximately 1,200 measurable objectives; fewer core objectives allows HP2030 to prioritize the most pressing public health issues in this country for the next decade while still representing additional public health issues with developmental and research objectives. HP2030 also has 23 Leading Health Indicators (LHIs) (**Table 1–7**) organized to

TABLE 1–7
Leading Health Indicators of Healthy People 2030

All Ages
Children, adolescents, and adults who use the oral healthcare system (2+ years)
Consumption of calories from added sugars by persons aged 2 years and over (2+ years)
Drug overdose deaths
Exposure to unhealthy air
Homicides
Household food insecurity and hunger
Persons who are vaccinated annually against seasonal influenza
Persons who know their HIV status (13+ years)
Persons with medical insurance (<65 years)
Suicides
Infants
Infant deaths
Children and Adolescents
Fourth grade students whose reading skills are at or above the proficient achievement level for their grade
Adolescents with major depressive episodes (MDEs) who receive treatment
Children and adolescents with obesity
Current use of any tobacco products among adolescents
Adults and Older Adults
Adults engaging in binge drinking of alcoholic beverages during the past 30 days
Adults who meet current minimum guidelines for aerobic physical activity and muscle-strengthening activity
Adults who receive colorectal cancer screening based on the most recent guidelines
Adults with hypertension whose blood pressure is under control
Cigarette smoking in adults
Employment among the working-age population
Maternal deaths
New cases of diagnosed diabetes in the population

TABLE 1–8
Healthy People 2030 Nutrition andHealthy Eating Objectives

General	NWS-01 Reduce household food insecurity and hunger NWS-02 Eliminate very low food security in children NWS-06 Increase fruit consumption for people aged 2 years and over NWS-07 Increase vegetable consumption for people aged 2 years and older NWS-08 Increase consumption of dark green vegetables, red and orange vegetables, and beans and peas for people aged 2 years and older NWS-09 Increase whole grain consumption for people aged 2 years and over NWS-10 Reduce consumption of added sugars for people aged 2 years and over NWS-11 Reduce consumption of saturated fats for people aged 2 years and over NWS-12 Reduce consumption of sodium for people aged 2 years and over NWS-13 Increase calcium consumption for people aged 2 years and over NWS-14 Increase potassium consumption for people aged 2 years and over NWS-15 Increase vitamin D consumption for people aged 2 years and over NWS-16 Reduce iron deficiency in children aged 1 to 2 years ECBP-D02 Increase the proportion of schools that don't sell less-healthy foods and drinks
Adolescents	AH-04 Increase the proportion of students participating in the School Breakfast Program AH-R03 Increase the proportion of eligible students participating in the Summer Food Service Program
Cancer	C-R01 Increase quality of life for cancer survivors
Diabetes	D-D01 Increase the proportion of eligible people completing CDC-recognized type 2 diabetes prevention programs
Heart Disease and Stroke	HDS-04 Reduce the proportion of adults with high blood pressure HDS-06 Reduce cholesterol in adults
Infants	MICH-15 Increase the proportion of infants who are breastfed exclusively through age 6 months MICH-16 Increase the proportion of infants who are breastfed at 1 year
Overweight and Obesity	NWS-03 Reduce the proportion of adults with obesity NWS-05 Increase the proportion of healthcare visits by adults with obesity that include counseling on weight loss, nutrition, or physical activity
Women	MICH-12 Increase the proportion of women of childbearing age who get enough folic acid NWS-17 Reduce iron deficiency in females aged 12 to 49 years
Workplace	ECBP-D05 Increase the proportion of worksites that offer an employee a nutrition program

Note: The numbering system is categorized by the workgroup assigned to each objective followed by the number of the objective. D indicates a developmental objective; R indicates a research objective.

U.S. Department of Health and Human Services, Healthy People 2030 Nutrition andHealthy Eating objectives. Retrieved from https://health.gov/healthypeople/objectives-and-data/browse-objectives/nutrition-and-healthy-eating/eliminate-very-low-food-security-children-nws-02

address the entire life span. All LHIs are core objectives. **Table 1–8** shows the principal objectives associated with HP2030's Nutrition and Healthy Eating objectives; 22 are core objectives, three are developmental objectives, and two are research objectives. Many of these nutrition objectives are similar to those of the DGA, as discussed below.

The NCHS is responsible for coordinating efforts to monitor progress toward the HP objectives. Data are gathered from over 80 sources, including the NCHS data systems[102] and other Federal Government data systems. Criteria for data sources for HP2030 include nationally representative, publicly available, and known population coverage, response rates, and documentation completeness. Data from HP2030 can be explored by viewing individual objectives or customizable groups of objectives in the Objectives and Data portion of the HP2030 website.[103]

For HP2020, many states developed their own HP plans.[104] Development of state-specific plans allowed states to prioritize health problems, address needs of specific racial or ethnic groups, and develop solutions that were economically feasible for state budgets. States and territories had a Healthy People Coordinator who served as a liaison with the OCPHP.

Pandemic Learning Opportunity

HP2030 includes a COVID-19 custom list of objectives pertaining to the pandemic. ODPHP provided a shareable link for this list, and the list is editable for individuals or groups that wish to use pandemic-related objectives. Take some time to review the list and consider how you might customize it for nutrition programs for the public. https://health.gov/healthypeople/objectives-and-data/browse-objectives/nutrition-and-healthy-eating

Nutrient Requirements

The first Recommended Dietary Allowances (RDAs) were published in 1941 "to serve as a basis for food relief efforts both in the United States and internationally, where war or economic depression had resulted in malnutrition or starvation."[105] The first edition included recommendations only for energy and nine nutrients: protein, thiamine, riboflavin, niacin, ascorbic acid, vitamins A and D, calcium, and iron. In the seventh edition (1968), additional nutrients were included: folate; vitamins E, B_6, and B_{12}; phosphorus; magnesium; and iodine. The last edition of the RDAs (1989) added vitamin K, zinc, and selenium. The RDAs should be geared to groups of healthy people, such as the military or school feeding programs, rather than to individuals. The RDAs are however, often used to assess the adequacy of an individual's diet.

In 1993, the question of whether the RDAs should be changed was posed by the National Academies of Sciences, Engineering, and Medicine's Health and Medicine Division (HMD) (formerly the Institute of Medicine's (IOM) Food and Nutrition Board (FNB)). Support for change included that: 1) sufficient, new scientific information had accumulated to substantiate reassessment of these recommendations; 2) sufficient data for efficacy and safety existed; reduction in the risk of chronic diet-related diseases needed to be considered—previously, the RDA had focused on preventing deficiency diseases; 3) upper levels of intake should be established where there were data concerning risk of adverse effects; and 4) components of food that gave possible health benefits. Components of food, not meeting the traditional concept of a nutrient—such as phytochemicals, should be reviewed, and if adequate data existed, reference intakes should be established.

Between 1994 and 2004, the then IOM's Food and Nutrition Board, Dietary Reference Intakes (FNB DRI) extended and replaced the former RDAs and the Canadian Recommended Nutrient Intakes.[106] The DRIs are available on the website of the Food and Nutrition Information Center of the National Agricultural Library. The DRIs are specified on age, gender, and lifestage (e.g., pregnancy or lactation) and cover more than 40 nutrient substances. Conceptually, the DRIs are the same as the RDAs in that their formulation relies on the best scientific evidence available at the time of issuance, are designed for healthy individuals over time, and can vary depending on life cycle stage or gender. The reference values for heights and weights of adults and children used in the DRIs are from NHANES III. The DRIs differ from the original RDAs in that they incorporate the concepts of disease prevention, upper levels of intake and potential toxicity, and nontraditional nutrients. The latter establishes a precedent; as scientists learn more about the relationship of phytochemicals, herbals, or botanicals and health, these too can be incorporated into the recommendations. Where scientific evidence is available, the DRIs are a set of at least four nutrient-based reference values. Briefly, the four reference values are the estimated average requirement (EAR), RDA, tolerable upper intake level (UL), and adequate intake (AI). The EAR is the median usual intake value estimated to meet the requirements of half of the healthy individuals; it is based on specific criteria of adequacy and is based on careful review of the scientific evidence. Not all nutrients have an EAR since there may not be an acceptable science base upon which to define one. The EAR is used to calculate the RDA (RDA = EAR + 2 standard deviations of the requirement), which is the average daily dietary intake level sufficient to meet the nutrient requirement of approximately 98% of individuals. If there is no EAR for a nutrient, there can be no RDA. If this is the case, an AI for the nutrient is provided. This value is deemed by experts and is intended to meet or to

Phytonutrients are compounds produced by plants that may have different effects on and benefits for the body. Scientists have identified thousands of these compounds, but only a fraction of them have been studied closely. Examples include carotenoids, isoflavones, and flavonoids. To learn more about phytonutrients, go to the USDA's Food and Nutrition Information Center page on phytonutrients: https://www.nal.usda.gov/fnic/phytonutrients. To learn more about dietary supplements, go to the National Institutes of Health's website for the Office of Dietary Supplements: https://ods.od.nih.gov

exceed the needs of a healthy population. The AI can be used as a guide for intake but cannot be used for all of the applications for which the EAR can; it is also an indication that additional research is required for a nutrient. The assumption is that when this research is completed and evaluated, the AI can be replaced by an EAR and RDA. The UL is the highest level of continued daily nutrient intake that is unlikely to pose an adverse health effect. It is important to note that the word "tolerable" was chosen to avoid implying a possible beneficial effect.

The HMD has published DRIs and related information for: electrolytes and water;[107] energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids;[108] vitamins A and K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc;[109] vitamin C, vitamin E, selenium, and carotenoids;[110] the B vitamins;[111] calcium, phosphorus, magnesium, vitamin D, and fluoride;[112] an updated volume on vitamin D and calcium;[113] and an updated volume on sodium and potassium.[114] A complete set of the DRI books is available online or can be ordered in book form.

Important uses of the DRIs include individual diet planning, dietary guidance, institutional food planning, military food and meal planning, planning for food assistance programs, food labeling and fortification, developing new or modified food products, and guaranteeing food safety. In planning menus/diets for individuals or groups, it is important to meet the RDA or AI without exceeding the UL. The HMD has incorporated the DRIs and other data into a series of reports, including School Meals: Building Blocks for Healthy Children,[115] Local Government Actions to Prevent Childhood Obesity,[116] the Public Effects of Food Deserts[117] (workshop summary), Nutrition Standards and Meal Requirements for National School Lunch and Breakfast Programs: Phase I. Proposed Approach for Recommending Revisions,[118] and the Use of Dietary Supplements by Military Personnel.[119] Summaries of the development of the DRI[113] as well as the uses of the DRI in dietary assessment[120,121] and to plan menus[122] can be found in the literature.

The National Agricultural Library has an online tool to calculate daily nutrient recommendations called the Interactive DRI for Health Professionals at https://www.nal.usda.gov/fnic/dri-calculator/DRI books are available online at: https://www.nal.usda.gov/fnic/dri-nutrient-reports

The Center for Nutrition Policy and Promotion

The CNPP, created in December of 1994, is an office of the USDA's Food and Nutrition Service. Its mission is "to improve the health and well-being of Americans by developing and promoting dietary guidance that links scientific research to the nutrition needs of consumers."[123] The CNPP carries out its mission to improve the health of Americans by: 1) serving as the Federal authority on evidence-based food, nutrition, and economic analyses to inform policy and programs; 2) translating science into actionable food and nutrition guidance for all Americans; and 3) leading national communication initiatives that apply science-based messages to advance consumers' dietary and economic knowledge and behaviors.[124]

The major projects of the CNPP are shown in **Table 1–9**.

TABLE 1–9
Projects of the Center for Nutrition Policy and Promotion

Dietary Guidelines for Americans	Nutrition Evidence Systematic Review
MyPlate/MiPlato	Nutrient Content of the U.S. Food Supply
Healthy Eating Index	Pregnancy and Birth to 24 Months Project
USDA Food Patterns	Health and Medicine Division Study
USDA Food Plans: Cost of Food	Archived Projects
Expenditures on Children by Families	

The CNPP considers MyPlate/MiPlato and the Start Simple with MyPlate App tools to help the public navigate healthy eating; it includes recipes in the MyPlate Kitchen and individualized meal plans with the MyPlate Plan.

Dietary Guidelines for Americans

The DGA[125] are the foundation of federal nutrition policy, nutrition education programs, and information activities. The DGA are evidence-based recommendations for food (and some nutrient) intake and are designed to promote health and reduce the risk of chronic disease for Americans throughout the lifespan, including during pregnancy. The National Nutrition Monitoring and Related Research Act of 1990 (Pubic Law [PL] 101-445) mandates that the DGA are developed and published jointly by the Departments HHS and USDA every 5 years.[60] This relatively quick turnaround time is a result of the changing science as new studies are added to the evidence base. The ninth edition of the DGA (2020–2025) was released in December of 2020 (earlier editions were published in 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2015) and includes a call to action: "Make Every Bite Count with the *Dietary Guidelines*." The 2020–2025 DGA will remain in effect until the 2025–2030 DGA is released. Changes in the DGA must reflect current scientific and medical knowledge that is available at the time of publication. Two important documents demonstrate the necessity of relying on a science base: The 1988 *Surgeon General's Report on Nutrition and Health*[126] and 1989 *National Research Council's Report, Diet and Health: Implications for Reducing Chronic Disease Risk*.[1]

The DGA appears as succinct statements of nutrition recommendations for the general public, as seen in **Table 1–10** and **Table 1–11**. The detailed discussion of the evidence and the initial recommendations are made by the Dietary Guidelines Advisory Committee. Take a moment to learn about the process of how the DGA are developed and what is available on the DGA website. Tools for client education and consumer information can be found on related websites such as Healthfinder.gov, MyPlate.gov, and Foodsafety.gov; these are linked on the DGA website. Additionally, Food Sources of Select Nutrients provides lists of foods that are good sources of calcium, potassium, dietary fiber, vitamin D, and iron. Two lists are provided: standard portions and smaller portions.

MyPlate is the "translation" of the DGA for the public,[127] although it also has information available for nutrition professionals.[128] This information includes Nutrition Communicators Network, Communicator's Guide, Teachers, Health Professionals, and MyPlate Graphic Resources.

The DGA dictates U.S. federal nutrition policies and programs, which directly affect nearly 45 million Americans receiving electronic benefits from the Supplemental Nutrition Assistance Program (SNAP);[130] 22.6 million children participating in the National School Lunch Program;[131] approximately 6.5 million women, infants, and children receiving benefits under the Special Supplemental Nutrition Program for Women, Infants, and Children program;[132,133] and 2.4 million adults over 60 years of age through the Older Americans Act Nutrition Services Program. [133] The DGA also

TABLE 1–10
The 2020–2025 Dietary Guidelines for Americans[125]

1. Follow a healthy dietary pattern at every life stage.
2. Customize and enjoy nutrient-dense food and beverage choices to reflect personal preferences, cultural traditions, and budgetary considerations.
3. Focus on matching food group needs with nutrient-dense foods and beverages and stay within calorie limits.
4. Limit foods and beverages higher in added sugars, saturated fat, and sodium, and limit alcoholic beverages.

TABLE 1–11
Key Recommendations that Support the Four Dietary Guidelines[125]

At every stage of life—infancy, toddlerhood, childhood, adolescence, adulthood, pregnancy, lactation, and older adulthood—it is never too early or too late to eat healthfully.

- **For approximately the first 6 months of life**, exclusively feed infants human milk. Continue to feed infants human milk through at least the first year of life, and longer if desired. Feed infants iron-fortified infant formula during the first year of life when human milk is unavailable or insufficient. Provide infants with supplemental vitamin D beginning soon after birth.
- **At approximately 6 months**, introduce infants to nutrient-dense complementary foods. Introduce infants to potentially allergenic foods along with other complementary foods. Encourage infants and toddlers to consume a variety of foods from all food groups. Include foods rich in iron and zinc, particularly for infants fed human milk.
- **From 12 months through older adulthood**, follow a healthy dietary pattern across the lifespan to meet nutrient needs, help achieve a healthy body weight, and reduce the risk of chronic diseases.

A healthy dietary pattern consists of nutrient-dense forms of food and beverages across all food groups, in recommended amounts, and within calorie limits.
The core elements that make up a health dietary pattern include:

- Vegetables of all types—dark green; red and orange; beans, peas, and lentils; starchy; and other vegetables
- Fruits, especially whole fruit
- Grains, at least half of which are whole grain
- Dairy, including fat-free or low-fat milk, yogurt, and cheese, and/or lactose-free versions and fortified soy beverages and yogurt as alternatives
- Protein foods, including lean meats, poultry, and eggs; seafood; beans, peas, and lentils; and nuts, seeds, and soy products
- Oils, including vegetable oils and oils in food, such as seafood and nuts

A small amount of added sugars, saturated fat, or sodium can be added to nutrient-dense foods and beverages to help meet food group recommendations, but foods and beverages high in these components should be limited. Limits include:

- **Added sugars**—Less than 10% of calories per day starting at age 2. Avoid foods and beverages with added sugars for those younger than age 2 years.
- **Saturated fat**—Less than 10% of calories per day starting at age 2 years.
- **Sodium**—Less than 2,300 milligrams per day—and even less for children younger than age 14 years.
- **Alcoholic beverages**—Adults of legal drinking age can choose not to drink or to drink in moderation by limiting intake to two drinks or fewer in a day for men and one drink or fewer in a day for women, when alcohol is consumed. Drinking less is better for health than drinking more. There are some adults who should not drink alcohol, such as women who are pregnant.

Key Dietary Principles are designed to help people meet the Guidelines and Key Recommendations to achieve a healthy dietary pattern:

- **Meet nutritional needs primarily from foods and beverages.** An underlying premise of the *Dietary* Guidelines is that nutritional needs should be met primarily from foods and beverages—specifically nutrient-dense foods and beverages. In some cases, when meeting nutrient needs is not otherwise possible, fortified foods and nutrient-containing dietary supplements are useful.
- **Choose a variety of options from each food group.** Enjoy different foods and beverages within each food group. This can help meet nutrient needs—and also allows for flexibility so that the *Dietary Guidelines* can be tailored to meet cultural and personal preferences.
- **Pay attention to portion size.** *Portion size* is a term often used to describe the amount of a food or beverage served or consumed in one eating occasion. It is important to pay attention to portion size when making food and beverage choices, particularly for foods and beverages that are not nutrient-dense.

In tandem with the recommendations above, Americans aged 2 years and above—children, adolescents, adults, and older adults—should meet the Physical Activity Guidelines for Americans to help promote health and reduce the risk of chronic disease. Americans should strive to achieve and maintain a healthy body weight. The relationship between diet and physical activity contributes to calorie balance and managing body weight. As such, the Dietary Guidelines for ages 3–17, adulthood, and older adulthood include a recommendation for physical activity.[129*]

*The Guidelines recommend that preschool-aged children be active throughout the day through active play in a variety of activity types (light, moderate, or vigorous intensity) for at least 3 hours per day for enhanced growth and development. Children and adolescents aged 6 to 17 year should do at least 60 minutes (1 hour) of moderate-to-vigorous aerobic activity each day. They also need to perform muscle- and bone-strengthening activities such as climbing on playground equipment, playing sports, and jumping rope.
For adults and older adults, do aerobic activity, muscle-strengthening activity, and move more and sit less.
For substantial health benefits, do one of the following for aerobic activity:

- 150–300 minutes (2 hours and 30 minutes to 5 hours) each week of moderate-intensity aerobic physical activity (such as brisk walking or tennis)

Adults of all ages need muscle-strengthening activity (such as lifting weights or doing push-ups) at least 2 days each week.

affects information policy in tools and resources including MyPlate, food labels, and federal nutrition education programs such as the Supplemental Nutrition Assistance Program Education (SNAP-Ed). SNAP-Ed includes resources like the *SNAP-Ed Toolkit: Obesity Prevention Interventions and Evaluation Framework*, which provides evidence-based policy, systems, and environmental changes that support direct educational social marketing and

ways to evaluate them across various settings.[134] The reliance on and the consistency of following the DGA assure that nutrition information promulgated by the government is the same for all federal programs. Although not mandated, the DGA also provide the foundation for nutrition recommendations and programs from nonfederal agencies such as the American Heart Association and the American Cancer Society.

MyPlate

In the United States, food group plans have provided dietary guidance based on current scientific knowledge for over 100 years. The USDA published its first recommendations in 1916. Between 1916 and the 1940s, plans had between five and 16 separate food groups and were published by various government agencies. In 1943, as part of the wartime effort, the USDA published the *National Wartime Nutrition Guide*. *The Basic Seven Food Guide*, derived from the *Wartime Guide*, was issued and was used until 1955 when the Department of Nutrition at the Harvard School of Public Health recommended collapsing the groups to four. This format was accepted by the USDA in 1956 and in 1979 a fifth group—fats, sweets, and alcohol—was added. These plans had two things in common: they were designed to meet nutrient requirements and to prevent nutritional deficiencies. As the relationship between diet and chronic disease risk and the development of the DGA, researchers understood how important it was to develop a food guidance system that included recommendations to prevent the excesses or poor food choices associated with chronic disease. In 1984, these groups were illustrated as a "Food Wheel" and the goals were shifted to a total diet approach for nutrient adequacy and moderation.

These efforts culminated with the Food Guide Pyramid that was released in 1992, MyPyramid in 2005, MyPlate in 2011, and MyPlate, MyWins in 2015. The introduction of MyPlate coincided with the release of the 2010 DGA.[135] With the release of DGA 2020–2025, the guide was changed back to MyPlate with a new *Start Simple with MyPlate* campaign. The MyPlate icon (**Figure 1–1**) depicts the five food groups: fruit, vegetables, grains, protein foods, and dairy foods, but it provides a new, simpler reminder to

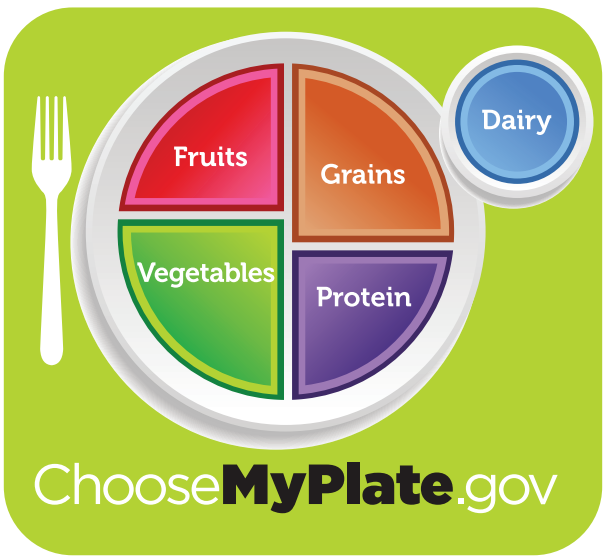


FIGURE 1–1 MyPlate.

Courtesy of USDA. Choose My Plate. http://www.choosemyplate.gov

TABLE 1–12
Consumer Messages for MyPlate

Core Message

- The benefits of healthy eating add up over time, bite by bite. Small changes matter. *Start Simple with MyPlate.*

Food Groups

- Fruits—Make half your plate fruits and vegetables: focus on whole fruits
- Vegetables—Make half your plate fruits and vegetables: vary your veggies
- Grains—Make half your grains whole grains
- Protein Foods—Vary your protein routine
- Dairy—Move to low-fat or fat-free dairy milk or yogurt (or lactose-free dairy or fortified soy versions)

Make every bite count

- Learn how much you need from each food group. Get a personalized MyPlate Plan that's right for you, based on your age, sex, height, weight, and physical activity level.
- Take a look at your current eating routine. Pick one or two ways that you can switch to choices today that are rich in nutrition.
- A healthy eating routine can help boost your health today and in the years to come. Think about how your food choices come together over the course of your day or week to help you create a healthy eating routine.
- It is important to eat a variety of fruits, vegetables, grains, protein foods, and dairy and fortified soy alternatives. Choose options for meals, beverages, and snacks that have limited added sugars, saturated fat, and sodium.

U.S. Department of Agriculture. Accessed January 31, 2021. Retrieved from https://www.myplate.gov/eat-healthy/what-is-myplate

choose healthy foods at mealtimes than either the Food Guide Pyramid or MyPyramid. *Start Simple with MyPlate* is designed to help people meet healthy eating goals one at a time. The *Start Simple with MyPlate* app helps consumers choose simple daily food goals, track progress toward goals, and learn helpful tips and recipes in line with their goals. It uses the five food groups to categorize nutrition goals; the app currently limits goals to three per food group with the option to edit goals at any time. The new MyPlate website contains a core message (*Start Simple with MyPlate*) as well as five consumer messages based on the five main food groups and four additional messages to support the "Make every bite count" call to action from the DGA 2020–2025. (**Table 1–12**[136]) The MyPlate website includes a variety of information about healthy food choices and videos to provide a visual for individuals.

MyPlate is more than simply an icon. The website provides easy-to-understand information on healthy food choices for all ages for both consumers and health professionals. In addition to the *Start Simple with MyPlate* app, tools also include a personalized MyPlate Plan to develop food group targets within a calorie allowance and MyPlate Quiz to help consumers identify gaps in their eating habits as well as resources to address those gaps. Toolkits for professionals are provided on the website as well and are geared toward registered dietitian dietitians/nutritionists, food producers and retailers, community and professional organizations, and communicators and educators.

Pandemic Learning Opportunity

Start Simple with MyPlate provides a tip sheet called Food Planning During the Coronavirus Pandemic that can help consumers navigate healthy eating while they adjust to a new routine with the quarantines and social distancing required during the pandemic. Links to additional information about Coronavirus/COVID-19 as well as additional food planning resources are also included further down the page. https://www.myplate.gov/eat-healthy/healthy-eating-budget/covid-19

Healthy Eating Index Provides a measure of diet quality that assesses how well a set of foods aligns with key recommendations in the Dietary Guidelines for Americans.

Healthy Eating Index

The **Healthy Eating Index (HEI)** provides a measure of diet quality that assesses how well a set of foods aligns with key recommendations in the DGA.[137-139] Originally developed by the CNPP in 1995 using 1989–1990 Continuing Survey of Food Intakes by Individuals (CSFII) data, it is updated every 5 years as new DGA are released using NHANES data. The updates reflect collaboration between the CNPP and the National Cancer Center. Plans to update the HEI to align with the 2020–2025 DGA are underway. The scoring metric for the HEI-2015 is composed of 13 components, each of which is assigned a standard for achieving both a maximum and minimum (zero) score. The components are summed for a total possible score of 100. Of the components, nine: total fruits, whole fruits, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acid ratios receive "adequacy scores." These are foods to encourage and a higher score indicates higher consumption. The four remaining components: refined grains, sodium, added sugars, and saturated fats, receive a "moderation score" and a higher score indicates lower consumption (**Figure 1–2**).[139] Recently it was shown, using NHANES 2011-2012 data, that the total population (≥2 years of age; n=7,933) had a total score of 59.0±0.95 (standard error); children (2–17 years of age; n=2,857) had a total score of 55.07±0.72; and older adults (≥65 years of

HEI–2015[1] Components & Scoring Standards

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Adequacy:			
Total Fruits[2]	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
Whole Fruits[3]	5	≥0.4 cup equiv. per 1,000 kcal	No Whole Fruit
Total Vegetables[4]	5	≥1.1 cup equiv. per 1,000 kcal	No Vegetables
Greens and Beans[4]	5	≥0.2 cup equiv. per 1,000 kcal	No Dark Green Vegetables or Legumes
Whole Grains	10	≥1.5 oz equiv. per 1,000 kcal	No Whole Grains
Dairy[5]	10	≥1.3 cup equiv. per 1,000 kcal	No Dairy
Total Protein Foods[6]	5	≥2.5 oz equiv. per 1,000 kcal	No Protein Foods
Seafood and Plant Proteins[6,7]	5	≥0.8 oz equiv. per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acids[8]	10	(PUFAs + MUFAs)/SFAs ≥2.5	(PUFAs + MUFAs)/SFAs ≤1.2
Moderation:			
Refined Grains	10	≤1.8 oz equiv. per 1,000 kcal	≥4.3 oz equiv. per 1,000 kcal
Sodium	10	≤1.1 gram per 1,000 kcal	≥2.0 grams per 1,000 kcal
Added Sugars	10	≤6.5% of energy	≥26% of energy
Saturated Fats	10	≤8% of energy	≥16% of energy

[1] Intakes between the minimum and maximum standards are scored proportionately.
[2] Includes 100% fruit juice.
[3] Includes all forms except juice.
[4] Includes legumes (beans and peas).
[5] Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.
[6] Includes legumes (beans and peas).
[7] Includes seafood, nuts, seeds, soy products (other than beverages), and legumes (beans and peas).
[8] Ratio of poly- and monounsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).

FIGURE 1–2 HEI–2015[1] Components & Scoring Standards.

National Institutes of Health. Accessed January 31, 2021. Retrieved from https://epi.grants.cancer.gov/hei/developing.html#2015c

age; n=1,032) had a total score of 68.29±1.76.[139] In addition to age being associated with better diet quality, HEI scores are also higher in individuals with higher incomes and more education.[140] Overall, in the United States, diet quality appears to be slowly improving; it's not clear, however, if improvement will be rapid enough to meet all of the HP 2020 nutrition goals. Only improvements in whole fruit intake and empty calories appear to be on track to meet these goals.[141]

Tools for researchers, including basic steps to calculate HEI scores at different levels: national food supply, food processing, community food environment, and individual food intake, and SAS Macros are available for calculating the HEI-2005, the HEI-2010, and the HEI-2015.[142]

The Food Label

The **Nutrition Labeling and Education Act (NLEA) of 1990 (Public Law [PL] 101-535)** amended the Federal Food, Drug, and Cosmetic Act to provide, among other things, that certain nutrients and food components be included on the label. The regulatory authority for the food label rests with the U.S. Food and Drug Administration (FDA) and the Federal Trade Commission. The Secretary of HHS (and by delegation, the FDA) can add or delete nutrients included in the food label or labeling if this action is necessary to assist consumers in maintaining healthy dietary practices. In response to these provisions, in the Federal Register of November 27, 1991, the FDA published a proposed rule titled, "*Food Labeling: Reference Daily Intakes and Daily Reference Values; Mandatory Status of Nutrition Labeling and Nutrient Content Revision*." In that document, the agency proposed to require that foods bear nutrition labeling listing certain nutrients and the amount of those nutrients in a serving of the food.

Under the NLEA, some foods are exempted from the food labeling laws: food served for immediate consumption (e.g., that served in hospital cafeterias and airplanes), and sold by food service vendors (e.g., mall cookie counters, sidewalk vendors, and vending machines); ready-to-eat food that is not for immediate consumption but is prepared primarily on site (e.g., bakery, deli, and candy store items); food shipped in bulk as long as it is not for sale in that form to consumers; medical foods (e.g., those used to address the nutritional needs of patients with certain diseases); plain coffee and tea, some spices; and other foods with no significant amounts of any nutrients.

Placement of information on the label, type size, manufacturer name and contact information, and other information related to content are also mandated. To accommodate foods sold in small packages, there are special requirements. Furthermore, the USDA regulates poultry in accordance with the Poultry Products Inspection Act and meat under the Federal Meat Inspection Act. Daily values (DV) are one of the key elements of the food label; these are the daily dietary intake standards used for nutrition labeling. The first daily intake standards, referred to as the U.S. Recommended Daily Allowances, for the nutrition label were established in 1973 and were based on the RDAs.[142-144]

Food label criteria continue to change to meet current scientific research and public demand. Another example is the Food Allergen Labeling and Consumer Protection Act of 2004 (Public Law [PL] 108-282, Title II), which mandated that as of January 1, 2006, foods containing or potentially containing any of the eight most common food allergens—milk, eggs, fish, Crustacean shellfish, tree nuts, peanuts, wheat, and soybeans—include the food name on the label in "plain English" (e.g., this product contains EGGS). These foods account for 90% of food allergic reactions in children and adults.

Nutrition Labeling and Education Act of 1990 (Public Law [PL] 101-535) Amended the Federal Food, Drug, and Cosmetic Act to provide certain nutrients, food components, and health claims (among other information) be included on the food labels. The law was amended in 2004 (PL 108-282, Title II) to mandate that foods containing or potentially containing the eight most common food allergens have that allergen included on the label in "plain English," e.g., the food contains EGGS. The law was amended again in 2016 to update labeling regulations for foods and dietary supplements to assist consumers in making healthy food choices using a newly designed Nutrition Facts Label.

The FDA also provides guidance for industry from a standpoint of allergens and potential allergens in the food.[145] Although gluten is not an allergen, in 2013, the FDA set a threshold for gluten of less than 20 parts per million in foods that are labeled "gluten-free," "no gluten," "free of gluten," and "without gluten."[146]

In 2016, the FDA amended the labeling regulations for foods and dietary supplements to assist consumers in making healthy food choices using the Nutrition Facts Label.[147] The new Nutrition Facts Label updated the list of nutrients required (or permitted) to be declared, updated Daily Reference Values and Reference Daily Intake values to align with current dietary recommendations, amended requirements for foods that claim to be specifically for children under age 4 and pregnant and lactating women and established nutrient reference values for these populations, and revised the format of the Nutrition Facts Label. The final rule became effective in July 26, 2016; originally, the compliance date was 2 years later in 2018 for manufacturers with $10 million or more in annual food sales and 3 years later in 2019 for manufacturers with less than $10 million in annual food sales. These compliance dates were extended to 2020 and 2021, respectively, to allow for sufficient time to make the changes. **Figure 1–3** shows the difference between the old and new Nutrition Facts Labels. Six Key Changes were made to information

Nutrition Facts
Serving Size 2/3 cup (55g)
servings Per Container About 8

Amount per serving
Calories 230 Calories from Fat 72

	% Daily Value*
Total Fat 8g	**12%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**12%**
Dietary Fiber 4g	**16%**
Sugars 1g	
Protein 3g	
Vitamin A	10%
Vitamin C	8%
Calcium	20%
Iron	45%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily value may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat. Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Nutrition Facts
8 servings per container
Serving size **2/3 cup (55g)**

Amount per serving
Calories **230**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 235mg	6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

FIGURE 1–3 Comparison of the Original and New Nutrition Facts Labels.

U.S. Food and Drug Administration. Changes to the Nutrition Facts Label. Retrieved from https://www.fda.gov/media/99331/download

TABLE 1–13
The Six Key Changes to the Nutrition Facts Label

1. Servings	- Serving size in larger, bold font - Servings per container in larger font - Serving sizes were updated to "better reflect the amount people typically eat and drink"; food and beverage items in containers that contain 1–2 servings but could be eaten in one sitting require nutrition facts for the entire container; a second column may be added to provide a smaller serving size for part of the container if desired
2. Calories	- Calories in a larger, bold font
3. Fat	- Calories from Fat is removed since research shows that type of fat is more important than amount
4. Added Sugars	- "Added sugars" in grams and as a percent Daily Value (%DV) is now required - This information is added in a line below "Total Sugars" and written as "Includes __g Added Sugars" - Added sugars include sugars added during food processing (such as dextrose or sucrose), foods packaged as sweeteners (such as table sugar or brown sugar), sugars from syrups and honey, and sugars from concentrated fruit or vegetable juice
5. Nutrients	- Vitamin D and potassium are now required - Vitamins A and C are no longer required - Amount in milligrams or micrograms and %DV must be listed for vitamin D, calcium, iron, and potassium - Daily Values for nutrients updated based on newer scientific evidence; these are used to calculate the %DV on the label
6. Footnote	- The footnote at the bottom of the label is adjusted to better explain the meaning of %DV

and/or appearance on the Label: servings, calories, fat, added sugars, nutrients, and footnote (**Table 1–13**).[148-149]

Food and Dietary Supplement Claims

As mandated by the NLEA of 1990, the FDA issued the final food labeling rules for health claims. Updated in 2008, information on the FDA website qualifies and explains claims that can be made for conventional food and dietary supplements. The claims fall into four categories: 1) Nutrient Content Claims; 2) Health Claims; 3) Qualified Health Claims (QHC); and 4) Structure Function Claims.[150] Nutrient Content Claims are fairly straightforward, including words like *free*, *high*, *low*, *more*, *reduced*, or *lite* (e.g., calorie free: <5 kcal per reference amount customarily consumed (RACC) per labeled serving or low calorie: ≤40 kcal per RACC). Furthermore, "when levels exceed: 13 g Total Fat, 4 g Saturated Fat, 60 mg Cholesterol, and 480 mg Sodium per RACC, per labeled serving or, for foods with small RACC, per 50 g, a disclosure statement is required as part of claim (e.g., "See nutrition information for content" with the blank filled in with nutrient(s) that exceed the prescribed levels). Nutrient Content Claims also encompass conditions for the use of "healthy."[151]

Health claims on foods and dietary supplements are more complicated but can be made after such statements have been reviewed and authorized by the FDA. Before industry can place such a claim on a label, stringent requirements must be met; there are also specific criteria that all foods must fulfill to be allowed to bear such health claims.[152] The FDA has provided industry guidance on the *evidence-based review system* that the FDA uses to evaluate the publicly available scientific evidence for significant scientific agreement health claims or qualified health claims (QHC) on the relationship between a substance and a disease or health-related condition. Approved claims must be clearly stated along with the requirements for the food, the claim requirements, and model claim; statements are available on the FDA's website.[153] The FDA has acknowledged that consumers benefit from more information on food labels about diet and health. The FDA thus established interim

procedures whereby QHCs can be made for conventional foods and for dietary supplements. Past court decisions have clarified the need to provide for health claims based on less scientific evidence rather than just on the standard of SSA as long as the claims do not mislead the consumers. The FDA began considering QHCs under its interim procedures on September 1, 2003. **Table 1–14a-c** show the health claims and qualified health claims allowed on food labels.[152,153] Finally, structure/function claims are allowed on labels.

TABLE 1–14A
Health Claims Subject to Enforcement Discretion[152]

- Calcium and Osteoporosis and Calcium, Vitamin D, and Osteoporosis
- Dietary Fat and Cancer
- Sodium and Hypertension
- Dietary Saturated Fat and Cholesterol and the Risk of Coronary Heart Disease
- Fiber-Containing Grain Products, Fruits, and Vegetables and Cancer
- Fruits, Vegetables and Grain Products that contain Fiber, particularly Soluble Fiber, and Risk of Coronary Heart Disease
- Fruits and Vegetables and Cancer
- Folate and Neural Tube Defects
- Dietary Non-Cariogenic Carbohydrate Sweeteners and Dental Caries
- Soluble Fiber from Certain Foods and Risk of Coronary Heart Disease
- Soy Protein and Risk of Coronary Heart Disease
- Plant Sterol/stanol esters and Risk of Coronary Heart Disease

TABLE 1–14B
FDA Modernization Act Health Claims (Health Claims Authorized Based on an Authoritative Statement by Federal Scientific Bodies)[152]

- Whole Grain Foods and Risk of Heart Disease and Certain Cancers
- Whole Grain Foods with Moderate Fat Content and Risk of Heart Disease
- Potassium and the Risk of High Blood Pressure and Stroke
- Fluoridated Water and Reduced Risk of Dental Carries
- Saturated Fat, Cholesterol, and Trans Fat, and Reduced Risk of Heart Disease
- Substitution of Saturated Fat in the Diet with Unsaturated Fatty Acids and Reduced Risk of Heart Disease

TABLE 1–14C
Qualified Health Claims Subject to Enforcement Discretion

- 0.8 mg Folic Acid & Neural Tube Birth Defects
- B Vitamins & Vascular Disease
- Selenium & Cancer
- Antioxidant Vitamins & Cancer
- Phosphatidylserine & Cognitive Dysfunction and Dementia
- Nuts & Heart Disease
- Walnuts & Heart Disease
- Omega-3 Fatty Acids & Coronary Heart Disease
- Monounsaturated Fatty Acids from Olive Oil and Coronary Heart Disease
- Green Tea & Cancer
- Chromium Picolinate & Cancer
- Calcium and Colon/Rectal Cancer & Calcium and Recurrent Colon/Rectal Polyps
- Calcium & Hypertension, Pregnancy-Induced Hypertension, and Preeclampsia
- Tomatoes and/or Tomato Sauce & Prostate, Ovarian, Gastric, and Pancreatic Cancers
- Unsaturated Fatty Acids from Canola Oil and Reduced Risk of Coronary Heart Disease
- Corn Oil and Corn Oil-Containing Products and a Reduced Risk of Heart Disease
- 100% Whey Protein Partially Hydrolyzed Infant Formula & Atopic Dermatitis

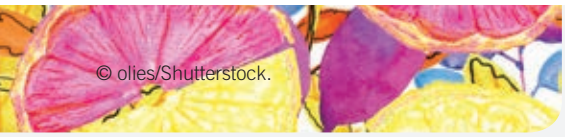
These differ from health claims in that structure/function claims describe the role of a substance intended to maintain the structure or function of the body. Structure/function claims do not require preapproval by the FDA. Products with structure/function claims must include this disclaimer: "This statement has not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease." Examples are "calcium builds strong bones" and "antioxidants maintain cell integrity."[150]

Helping clients understand food labels—including 1) using them to make careful food selections, which may reduce or even prevent chronic disease, 2) providing specific information targeted to individuals with certain disease states, and 3) integrating foods into a total food plan—is clearly within your purview as a nutrition professional. Information on how to read the food label and educating the public on the changes to the Nutrition Facts label is available online.[153]

Summary

Often, there are complaints that nutrition recommendations are conflicting and confusing; however, these recommendations are remarkably similar across agencies, including the **Dietary Guidelines for Americans**, the American Heart Association, the American Cancer Institute, and therapeutic diets like Dietary Approaches to Stop Hypertension. Why? Because the recommendations are based on what the evidence behind the programs dictates. The challenge for all nutrition professionals is to evaluate the scientific evidence critically before it is translated into public health practice. Nutrition professionals need to use this information to design, execute, and evaluate programs and policies so that positive recommendations are communicated to the public in a unified way. Doing so assures that consumers are getting the most accurate and comprehensive information available, which allows them to make positive lifestyle changes. This chapter reviewed the science behind public health policies, programs, nutrition education materials, and legislation.

Dietary Guidelines for Americans These are evidence-based recommendations for food (and some nutrient intake) and are designed to promote health and reduce the risk of chronic disease for healthy Americans across their entire lifespan. They are the foundation of federal nutrition policy, nutrition education programs, and information activities.



Learning Portfolio

Key Terms

Issues for Discussion

1. Dietary recommendations for the public change as scientific studies discover new information. How can these changes be brought to the public in a way that doesn't confuse them or make them feel resentful?
2. What ethical responsibility, if any, does industry or the media have in assuring the public's health?
3. The Dietary Guidelines for Americans and MyPlate promote healthy dietary patterns, but Americans clearly have difficulty following these recommendations. Why? If people cannot follow them, should we continue to make these recommendations?
4. The changes to the Nutrition Facts Label are designed to help consumers better navigate healthy eating by making nutrition information of food choices more intuitive. Do you think the new Nutrition Facts Label will achieve this? Why or why not?

Case Study: HP 2030 vs. DGA 2020–2025

Both *Healthy People 2030* and the Dietary Guidelines for Americans 2020–2025 reduced the quantity of their objectives and goals in order to focus on the priority of health needs of Americans. Work in pairs to choose 2–3 *HP 2030* objectives or one DGA 2020–2025 goal and follow the evidence to figure out why those objectives or goals were chosen and how they differ from the previous iteration of their respective programs.

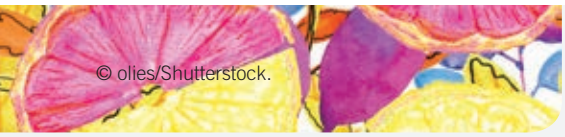
Case Study: Using the Evidence-Based Approach

Pick any topic in this chapter and show, step-by-step, how you would go about finding more valid information concerning the issue.

References

1. National Academy of Sciences, National Research Council, Food and Nutrition Board. *Diet and Health: Implications for Reducing Chronic Disease Risk*. Washington, DC: National Academy Press; 1989.
2. U.S. Senate Select Committee on Nutrition and Human Needs. *Dietary Goals for the United States*, 2nd ed. Washington, DC, U.S. Government Printing Office; 1977.
3. Centers for Disease Control and Prevention. National Center for Health Statistics. FastStats. *Deaths and Mortality*. Accessed January 31, 2021. https://www.cdc.gov/nchs/fastats/deaths.htm
4. Benjamin EJ, Virani SS, Callaway CW, et al. Heart Disease and Stroke Statistics—2018 Update: A report from the American Heart Association. *Circulation*. 2018;137(12):e67-e492.

5. National Cancer Institute. *Cancer Prevalence and Cost of Care Projections*. Accessed January 31, 2021. https://costprojections.cancer.gov
6. American Diabetes Association. Economic costs of diabetes in the U.S. in 2017. 2018;41(5):917-928.
7. Trogdon JG, Murphy LB, Khavjou OA, et al. Costs of chronic diseases at the state level: the chronic disease cost calculator. *Prev Chronic Dis*. 2015;12:E140.
8. National Kidney Foundation. *Kidney Disease: The Basics*. Accessed January 31, 2021. https://www.kidney.org/news/newsroom/factsheets/KidneyDiseaseBasics
9. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity among adults and youth: United States, 2015–2016. *NCHS Data Brief*. 2017;(288):1-8.
10. Centers for Disease Control and Prevention. About Child & Teen BMI. Accessed April 10, 2016. http://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html
11. Biener A, Cawley J, Meyerhoefer C. The high and rising costs of obesity to the US healthcare system. *J Gen Intern Med*. 2017;32(suppl 1):S6-S8.
12. World Health Organization. *Noncommunicable diseases*. Updated 1 June 2018. Accessed January 31, 2021. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases
13. World Health Organization. Global action plan for the prevention and control of noncommunicable diseases: 2013-2020. 2013.
14. Virani SS, Alonso A, Benjamin EJ, et al. Heart disease and stroke statistics—2020 update: a report from the American Heart Association. *Circulation*. 2020;141(9):e139-e596.
15. Goldman L, Benjamin G, Hernandez S, et al. Advancing the health of communities and populations: a vital direction for health and health care. *NAM Perspectives. Discussion Paper*, National Academy of Medicine, Washington, DC. 2016.
16. Curry L. The Future of the Public's Health in the 21st Century. Institute of Medicine. Board on Health Promotion and Disease Prevention. Washington DC: The National Academies Press; 2003.
17. Dzau VJ, McClellan MB, McGinnis JM, et al. Vital directions for health and health care: priorities from a National Academy of Medicine initiative. *JAMA*. 2017;327(14):1461-1470.
18. Wahl DR, Villinger K, Blumenschein M, et al. Why we eat what we eat: assessing dispositional and in-the-moment eating motives by using ecological momentary assessment. *JMIR mHealth and uHealth*. 2020;8(1):e13191.
19. Dover RV, Lambert EV. "Choice Set" for health behavior in choice-constrained settings to frame research and inform policy: examples of food consumption, obesity and food security. *Int J Equity Health*. 2016;15(48).
20. Cecchini M, Warin L. Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies. *Obes Rev*. 2016;17(3):201-210.
21. Hardcastle SJ, Thøgersen-Ntoumani C, Chatzisarantis NL. Food choice and nutrition: a social psychological perspective. *Nutrients*. 2015;7(10):8712-8715.
22. VanKim NA, Erickson DJ, Laska MN. Food shopping profiles and their association with dietary patterns: a latent class analysis. *J Acad Nutr Diet*. 2015;115(7):1109-1116.
23. Kamerow D. Why don't people exercise, even a little? *BMJ*. 2015;350:h3024.
24. Côté-Lussier C, Fitzpatrick C, Séguin L, Barnett TA. Poor, unsafe, and overweight: the role of feeling unsafe at school in mediating the association among poverty exposure, youth screen time, physical activity, and weight status. *Am J Epidemiol*. 2015;182(1):67-79.
25. Iso-Ahola SE. Conscious-nonconscious processing explains why some people exercise but most don't. *Journal of Nature and Science (JNSCI)*. 2017;3(6):e384.
26. Jung EH, Walsh-Childers K, Kim HS. Factors influencing the perceived credibility of diet-nutrition information web sites. *Comput Human Behav*. 2016;58:37-47.
27. Mayo Clinic. Healthy lifestyle: nutrition and healthy eating. *Nutrition Claims: How to tell fact from fiction*. Accessed February 7, 2021. https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/nutrition-claims-how-to-tell-fact-from-fiction/art-20300972
28. Adamski M, Truby H, Klassen KM, Cowan S, Gibson S. Using the Internet: nutrition information-seeking behaviours of lay people enrolled in a massive online nutrition course. *Nutrients*. 2020;12(3):1-18.
29. Health Literacy Online. A Guide for Simplifying the User Experience. Accessed April 11, 2016. http://health.gov/healthliteracyonline
30. Center for Evidence-Based Medicine. Levels of evidence: an introduction. Accessed February 7, 2021. https://www.cebm.ox.ac.uk/resources/levels-of-evidence/levels-of-evidence-introductory-document
31. Academy of Nutrition and Dietetics. Evidence Analysis Library. *Evidence-Based Practice*. Accessed February 7, 2021. https://www.andeal.org/evidence-based-practice
32. Agency for Healthcare Research and Quality. Evidence-based Practice Centers (EPC) Program overview. Accessed April 11, 2016. http://www.ahrq.gov/research/findings/evidence-based-reports/overview/index.html
33. Guyatt G, Rennie D, Meade MO, Cook DJ. Users' guides to the medical literature. Essentials of evidence-based clinical practice. *JAMA Evidence*. 3rd ed. 2015. New York. McGraw Hill Education.
34. Mueller C, Compher C, Ellen DM, American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.) Board of Directors. A.S.P.E.N. clinical guidelines: nutrition screening, assessment, and intervention in adults. *JPEN J Parenter Enteral Nutr*. 2011;35(1):16-24.
35. Academy of Nutrition and Dietetics. Evidence Analysis Library. *Nutrition Screening in Adults*. Accessed February 7, 2021. https://andeal.org/topic.cfm?menu=5382
36. Nutrition screening as easy as mana: a guide to completing the Mini Nutritional Assessment (MNA®). Nestlé Nutrition Institute. Accessed April 11, 2016. http://www.mna-elderly.com/forms/mna_guide_english.pdf
37. Dietitian/Dietitians/nutritionists from the Nutrition Education Materials Online. *Validated malnutrition screening and*

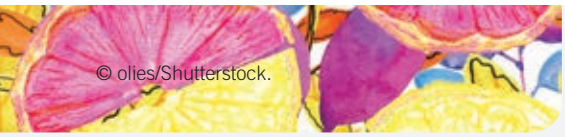


Learning Portfolio

assessment tools: comparison guide. Accessed February 7, 2021. https://www.health.qld.gov.au/__data/assets/pdf_file/0021/152454/hphe_scrn_tools.pdf

38. American Diabetes Association. *About the risk test.* Accessed February 7, 2021. https://diabetes.org/risk-test
39. United States Department of Agriculture, Economic Research Service. *Food security in the United States: survey tools*. Accessed February 7, 2021. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/survey-tools
40. Academy of Nutrition and Dietetics. *Nutrition Assessment Snapshot*. 2018. Accessed February 8, 2021. https://www.ncpro.org/nutrition-assessment-snapshot
41. National Cancer Institute. Dietary Assessment Primer. Accessed February 8, 2021. https://dietassessmentprimer.cancer.gov
42. Eldridge AL, Piernas C, Illner A-K, et al. Evaluation of new technology-based tools for dietary intake assessment—an ILSI Europe dietary intake and exposure task force evaluation. *Nutrients*. 2019;11(1):55.
43. McClung HL, Ptomey LT, Shook RP, et al. Dietary intake and physical activity assessment: current tools, techniques, and technologies for use in adult populations. *Am J Prev Med*. 2018;55(4):e93-e104.
44. National Center for Health Statistics. *What We Eat In America, DHHS–USDA Dietary Survey*. Accessed February 8, 2021. https://www.cdc.gov/nchs/nhanes/wweia.htm
45. National Cancer Institute. *Usual Dietary Intakes: The NCI method*. Accessed February 8, 2021. https://epi.grants.cancer.gov/diet/usualintakes/method.html
46. Food and Agriculture Organization of the United Nations. *Dietary Assessment: A Resource Guide to Method Selection and Application in Low Resources Settings*. Rome, Italy; 2018.
47. Molag ML, de Vries JH, Ocké MC, et al. Design characteristics of food frequency questionnaires in relation to their validity. *Am J Epidemiol*. 2007;166(12):1468-1478.
48. Martin CK, Correa JB, Han H, et al. Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time. *Obesity (Silver Spring)*. 2012;20(4):891-899.
49. U.S. Department of Agriculture. MyPlate. *Start Simple with MyPlate App*. Accessed January 30, 2021. https://www.myplate.gov/resources/tools/startsimple-myplate-app
50. United States Department of Agriculture. Food patterns equivalents database. Accessed February 8, 2021. https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/fped-overview/
51. United States Department of Agriculture. FoodData Central. Accessed February 8, 2021. https://fdc.nal.usda.gov
52. United States Department of Agriculture. Agriculture Research Service. Food and nutrient database for dietary studies. Accessed January 30, 2021. https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/fndds/
53. World Health Organization. *Report of the technical discussions at the twenty first World Health Assembly on "national and global surveillance of communicable diseases."* A2.1. 18-5-1968. Geneva, Switzerland.
54. U.S. Department of Agriculture. Economic Research Service. Guess who's turning 100? Tracking a century of American eating. Accessed February 8, 2021. https://www.ers.usda.gov/amber-waves/2010/march/guess-who-s-turning-100-tracking-a-century-of-american-eating/
55. U.S. Department of Agriculture, Agricultural Research Service. *History of Human Nutrition Research in the U.S. Department of Agriculture, Agricultural Research Service: People, Events, and Accomplishments.* Washington, DC: 2017.
56. National Research Council (US) Coordinating Committee on Evaluation of Food Consumption Surveys. *National Survey Data on Food Consumption: Uses and Recommendations.* Washington (DC): National Academies Press (US); 1984.
57. Centers for Disease Control and Prevention, National Center for Health Sciences. *National Health and Nutrition Examination Survey: History*. Accessed February 8, 2021. www.cdc.gov/nchs/nhanes/history.htm
58. U.S. Department of Health, Education, and Welfare; Health Services and Mental Health Administration; and Centers for Disease Control and Prevention. *Ten-state nutrition survey, 1968-1970. Highlights.* Atlanta, GA: 1972.
59. United States Environmental Protection Agency. Science Inventory. *Pediatric Nutrition Surveillance System (PEDNSS)*. Accessed February 8, 2021. https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=OEI&dirEntryID=132414
60. Congress.gov. *H.R.1608 – National Nutrition Monitoring and Related Research Act of 1990.* Accessed January 30, 2021. https://www.congress.gov/bill/101st-congress/house-bill/1608/summary/00
61. Centers for Disease Control and Prevention, National Center for Health Statistics. *What we eat in America, dietary survey integration*. Accessed February 7, 2021. https://www.cdc.gov/nchs/nhanes/wweia.htm
62. Centers for Disease Control and Prevention, National Center for Health Statistics. *National Health and Nutrition Examination Survey*. Accessed February 8, 2021. https://www.cdc.gov/nchs/nhanes/index.htm
63. Ahluwalia N, Dwyer J, Terry A, Moshfegh A, Johnson C. Update on NHANES dietary data: focus on collection, release, analytical considerations, and uses to inform public policy. *Adv Nutr*. 2016;7(1):121-134.
64. Eicher-Miller HA, Fulgoni VL 3rd, Keast DR. Energy and nutrient intakes from processed foods differ by sex, income status, and race/ethnicity of US Adults. *J Acad Nutr Diet*. 2015;115(6):907-918.e6.
65. Brooks CJ, Gortmaker SL, Long MW, Cradock AL, Kenney EL. Racial/ethnic and socioeconomic disparities in hydration status among US adults and the role of tap water and other beverage intake. *Am J Public Health*. 2017;107(9):1387-1394.
66. Odutayo A, Gill P, Shepherd S, et al. Income disparities in absolute cardiovascular risk and cardiovascular risk factors in the United States, 1999-2004. *JAMA Cardiol*. 2017;2(7):782-790.
67. Divney AA, Echeverria SE, Thorpe LE, Trinh-Shevrin C, Islam NS. Hypertension prevalence jointly influenced by acculturation and gender in US immigrant groups. *Am J Hypertens*. 2019;32(1):104-111.

68. Berenson GS (ed). *Causation of Cardiovascular Risk Factors in Childhood: Perspectives on Cardiovascular Risk in Early Life*. New York: Raven Press; 1986:408.
69. Berenson GS, McMahan CA, Voors AW, et al. *Cardiovascular Risk Factors in Children–The Early Natural History of Atherosclerosis and Essential Hypertension*. New York: Oxford University Press; 1980:450.
70. Berenson GS, Wattigney WA, Bao W, Srinivasan SR, Radhakrishnamurthy B. Rationale to study the early natural history of heart disease: The Bogalusa Heart Study. *Am J Med Sci*. 1995;310(suppl 1):S22-S28.
71. Nicklas TA, Demory-Luce D, Yang SJ, Baranowski T, Zakeri I, Berenson G. Children's food consumption patterns have changed over two decades (1973–1994): The Bogalusa heart study. *J Am Diet Assoc*. 2004;104(7):1127-1140.
72. Nicklas TA, Hayes D, American Dietetic Association. Position of the American Dietetic Association: nutrition guidance for healthy children ages 2 to 11 years. *J Am Diet Assoc*. 2008;108(6): 1038-1044, 1046-1047. doi: 10.1016/j.jada.2008.04.005 . PMID: 18564454
73. Berenson GS, Wattigney WA, Tracy RE, et al. Atherosclerosis of the aorta and coronary arteries and cardiovascular risk factors in persons aged 6 to 30 years and studied at necropsy (The Bogalusa Heart Study). *Am J Cardiol*. 1992;70(9):851-858.
74. Strong JP, McGill HC Jr. The natural history of coronary atherosclerosis. *Am J Pathol* 1962;40(1):37-49.
75. Metha NJ, Khan AI. Cardiology's 10 greatest discoveries of the 20th century. *Tex Heart Inst J*. 2002;29(3):164-171.
76. Kannel WB, Dawber TR, Kagan A, Revotskie N, Stokes J. Factors of risk in the development of coronary heart disease—six year follow-up experience. The Framingham Study. *Ann Intern Med*. 1691;55:33-50.
77. Framingham Heart Study. Research Milestones. Accessed February 8, 2021. https://framinghamheartstudy.org/fhs-about /research-milestones/
78. National Institutes of Health; National Heart, Lung, and Blood Institute. *Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Final report*. 2002. Accessed February 4, 2021. https://www.nhlbi.nih.gov/files/docs/resources/heart/atp -3-cholesterol-full-report.pdf
79. Corlin L, Liu C, Lin H, et al. Proteomic signatures of lifestyle risk factors for cardiovascular disease: a cross-sectional analysis of the plasma proteome in the Framingham Heart Study. *J Am Heart Assoc*. 2021;10(1):e018020.
80. Framingham Heart Study. *Offspring Cohort*. Accessed February 8, 2021. https://framinghamheartstudy.org /participants/participant-cohorts/
81. Framingham Heart Study. *Researchers Awarded $26.56 Million NIH Grant for FHS Brain Aging Program (FHS-BAP)*. Accessed February 8, 2021. https://framinghamheartstudy .org/2020/09/21/fhs-bap/
82. Farris RP, Nicklas TA. Characterizing children's eating behavior. In: *Textbook of Pediatric Nutrition*. Suskind RM, Suskind LL, eds. New York: Raven Press; 1993:505-516.
83. Nicklas TA, Forcier JE, Webber LS, Berenson GS. School lunch assessment as part of a 24-hour dietary recall for children. *J Am Diet Assoc*. 1991;91(6):711-713.
84. Frank GC, Hollatz AT, Webber LS, Berenson GS. Effect of interviewer recording practices on nutrient intake—Bogalusa Heart Study. *J Am Diet Assoc*. 1984;84(12):1432-1436, 1439.
85. Davy KP, Davy BM. Advances in nutrition science and integrative physiology: insights from controlled feeding studies. *Front Physiol*. 2019;10:3141.
86. Appel LJ, Moore TJ, Obarzanek E, et al. A clinical trial of the effects of dietary patterns on blood pressure. *N Engl J Med*. 1997;336:1117-1124.
87. Sacks FM, Svetkey LP, Vollmer WM, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. *N Engl J Med*. 2001; 344:3-10.
88. Funk KL, Elmer PJ, Stevens VJ, et al. PREMIER—a trial of lifestyle interventions for blood pressure control: intervention design and rationale. *Health Promot Pract*. 2008;9(3):271-280.
89. Albanes D, Heinonen OP, Taylor PR, et al. α-Tocopherol and β-carotene supplements and lung cancer incidence in the Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study: effects of base-line characteristics and study compliance. *J Natl Cancer Inst*. 1996;88(21):1560-1570.
90. Omenn GS, Goodman G, Thornquist M, et al. The β-Carotene and Retinol Efficacy Trial (CARET) for chemoprevention of lung cancer in high risk populations: smokers and asbestos-exposed workers. *Cancer Res*. 1994;54(suppl 7): 2038s-2043s.
91. Block G, Patterson B, Subar A. Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. *Nutr Cancer*. 1992;18(1):1-29.
92. Steinmetz KA, Potter JD. Vegetables, fruit, and cancer. I. Epidemiology. *Cancer Causes Control*. 1991;2:325-357.
93. Le Marchand L, Hankin JH, Kolonel LN, Beecher GR, Wilkens LR, Zhao LP. Intake of specific carotenoids and lung cancer risk. *Cancer Epidemiol Biomarkers Prev*. 1993;2(3):183-187.
94. Steinmetz KA, Potter JD, Folsom AR. Vegetables, fruit, and lung cancer in the Iowa Women's Health Study. *Cancer Res*. 1993;53(3):536-543.
95. Smigel K. Beta carotene fails to prevent cancer in two major studies; CARET intervention stopped. *J Natl Cancer Inst*. 1996;88(3-4):145.
96. Go J, Chang, DH, Ryu YK, et al. Human gut microbiota *Agathobaculum butyriciproducens* improves cognitive impairment in LPS-induced and APP/PS1 mouse models of Alzheimer's disease. *Nutr Res*. 2021;86:96-108.
97. Wolf G. The effect of low and high doses of beta-carotene and exposure to cigarette smoke on the lungs of ferrets. *Nutr Rev*. 2002;60(3):88-90.
98. Russell RM. The enigma of β-carotene in carcinogenesis: what can be learned from animal studies. *J Nutr*. 2004; 134(1):262S-268S.
99. *Healthy People 2030*. Accessed January 30, 2021. https:// health.gov/healthypeople
100. US Department of Health and Human Services. *Healthy People: The Surgeon General's Report on Health Promotion and Disease*



Learning Portfolio

Prevention. Washington, DC: Government Printing Office; 1979: Section 25.

101. Perspectives in Disease Prevention and Health Promotion Implementing the 1990 Prevention Objectives: Summary of CDC's Seminar. *Morbid Mortal Wkly Rep*. 1983;32:21-24.
102. Centers for Disease Control and Prevention. *Surveys and Data Collection Systems*. Accessed April 11, 2016. http://www.cdc.gov/nchs/surveys.htm
103. Healthy People 2030. Objectives and data. Accessed January 30, 2021. https://health.gov/healthypeople/objectives-and-data
104. Healthy People 2020. State and territorial Healthy People plans. Accessed April 11, 2016. https://www.healthypeople.gov/2020/healthy-people-in-action/State-and-Territorial-Healthy-People-Plans
105. Murphy SP, Yates AA, Atkinson SA, Barr SI, Dwyer J. History of nutrition: the long road leading to the dietary reference intakes for the United States and Canada. *Adv Nutr*. 2016;7(1):157-168.
106. United States Department of Agriculture. National Agricultural Library. Dietary Reference Intakes. Accessed January 30, 2021. https://www.nal.usda.gov/fnic/dietary-reference-intakes
107. Institute of Medicine (U.S.). *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate*. Washington, DC: National Academies Press; 2005.
108. Institute of Medicine (U.S.). *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. Washington, DC: National Academies Press; 2005.
109. Institute of Medicine (U.S.). *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Washington, DC: National Academies Press; 2001.
110. Institute of Medicine (U.S.). *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, DC: National Academies Press; 2000.
111. Institute of Medicine (U.S.). *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline*. Washington, DC: National Academies Press; 1998.
112. Institute of Medicine (U.S.). *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington, DC: National Academies Press; 1997.
113. Institute of Medicine (U.S.). *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, DC: National Academies Press; 2011.
114. National Academies of Sciences, Engineering, and Medicine (U.S.). *Dietary Reference Intakes for Sodium and Potassium*. Washington, DC: The National Academies Press; 2019.
115. Institute of Medicine. *School Meals: Building Blocks for Healthy Children*. Washington, DC: National Academies Press; 2010. Accessed January 30, 2021. https://www.nap.edu/catalog/12751/school-meals-building-blocks-for-healthy-children
116. Institute of Medicine. *Local Government Actions to Prevent Childhood Obesity*. 2009. Accessed January 30, 2021. https://www.nap.edu/catalog/12674/local-government-actions-to-prevent-childhood-obesity
117. Institute of Medicine. *The Public Health Effects of Food Deserts. Workshop Summary*. 2009. Washington, DC: National Academies Press. Accessed January 30, 2021. https://www.nap.edu/catalog/12623/the-public-health-effects-of-food-deserts-workshop-summary
118. Institute of Medicine. *Nutrition Standards and Meal Requirements for National School Lunch and Breakfast Programs: Phase I. Proposed Approach for Recommending Revisions*. Washington, DC: National Academies Press; 2008. Accessed January 30, 2021. https://www.nap.edu/catalog/12512/nutrition-standards-and-meal-requirements-for-national-school-lunch-and-breakfast-programs
119. Institute of Medicine. *Use of Dietary Supplements by Military Personnel*. Washington, DC: National Academies Press; 2008. Accessed January 30, 2021. https://www.nap.edu/catalog/12095/use-of-dietary-supplements-by-military-personnel
120. Murphy SP, Poos MI. Dietary Reference Intakes: summary of applications in dietary assessment. *Public Health Nutr*. 2002;5(6a):843-849.
121. Murphy SP, Barr SI, Poos MI. Using the new dietary reference intakes to assess diets: a map to the maze. *Nutr Rev*. 2002;60(9):267-275.
122. Barr SI, Murphy SP, Agurs-Collins TD, Poos MI. Planning diets for individuals using the dietary reference intakes. *Nutr Rev*. 2003;61(10):352-360.
123. United States Department of Agriculture, Food and Nutrition Service. Center for Nutrition Policy and Promotion. Accessed January 30, 2021. https://www.fns.usda.gov/cnpp
124. United States Department of Agriculture, Food and Nutrition Service. Center for Nutrition Policy and Prevention. *About CNPP*. Accessed January 30, 2021. https://www.fns.usda.gov/about-cnpp
125. U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020-2025*. 9th edition. December 2020. Accessed January 30, 2021. https://www.dietaryguidelines.gov
126. U.S. Department of Health and Human Services, Public Health Service. *The Surgeon General's report on nutrition and health*. DHHS (PHS) Publication No. 88-50215; 1988.
127. United States Department of Agriculture. MyPlate. Accessed January 30, 2021. http://www.myplate.gov
128. United States Department of Agriculture. MyPlate, Professionals. Accessed January 30, 2021. http://www. myplate.gov/professionals
129. U.S. Department of Health and Human Services. *Physical Activity Guidelines for Americans, 2nd edition*. Accessed January 30, 2021. https://health.gov/our-work/physical-activity/current-guidelines
130. United States Department of Agriculture. Food and Nutrition Service. *SNAP Data Tables*. Accessed January 30, 2021. https://www.fns.usda.gov/pd/supplemental-nutrition-assistance-program-snap
131. United States Department of Agriculture. Food and Nutrition Service. National School Lunch Program. *Child Nutrition*

Tables. Accessed January 30, 2021. https://www.fns.usda.gov/pd/child-nutrition-tables

132. United States Department of Agriculture. Food and Nutrition Service. *WIC Data Tables*. Accessed January 30, 2021. https://www.fns.usda.gov/pd/wic-program
133. United States Department of Agriculture. Older Americans Act Nutrition Services Program. Accessed January 30, 2021. https://agid.acl.gov/Resources/DataOutputs/Data_Story_Nutrition_Services_Program.pdf
134. United States Department of Agriculture. SNAP-Ed Toolkit: Obesity Prevention Interventions and Evaluation Framework. *The Toolkit.* Accessed January 30, 2021. https://snapedtoolkit.org
135. United States Department of Agriculture. MyPlate. *A Brief History of USDA Food Guides.* Accessed January 30, 2021. https://www.myplate.gov/sites/default/files/2020-12/ABriefHistoryOfUSDAFoodGuides.pdf
136. United States Department of Agriculture. MyPlate. *What is MyPlate?* Accessed January 30, 2021. https://www.myplate.gov/eat-healthy/what-is-myplate
137. Kennedy ET, Ohls J, Carlson S, Fleming K. The Healthy Eating Index: design and applications. *J Am Diet Assoc*. 1995;95:1103-1108.
138. Bowman SA, Lino M, Gerrior SA, Basiotis PP. *The Healthy Eating Index: 1994-96*. U.S. Department of Agriculture, Center for Nutrition Policy and Promotion. Washington, DC: CNPP-5; 1998.
139. United States Department of Agriculture. Center for Nutrition Policy and Promotion. *Healthy Eating Index.* Accessed January 30, 2021. https://www.fns.usda.gov/resource/healthy-eating-index-hei
140. Drewnowski A, Aggarwal A, Cook A, Stewart O, Moudon AV. Geographic disparities in Healthy Eating Index scores (HEI–2005 and 2010) by residential property values: findings from Seattle Obesity Study (SOS). *Prev Med*. 2016;83:46-55.
141. Wilson MM, Reedy J, Krebs-Smith SM. American diet quality: where it is, where it is heading, and what it could be. *J Acad Nutr Diet*. 2016;116(2):302-310.
142. Pennington JA, Hubbard VS. Derivation of daily values used for nutrition labeling. *J Am Diet Assoc*. 1997;97:1407–1412.
143. Origin and framework of the development of dietary reference intakes. *Nutr Rev*. 1997;55:332-334.
144. U.S. Food & Drug Administration. *Nutrition Labeling and Education Act (NLEA) Requirements-Attachment 1.* Accessed January 31, 2021. https://www.fda.gov/nutrition-labeling-and-education-act-nlea-requirements-attachment-1
145. U.S. Food and Drug Administration. Guidance & Regulation (Food and Dietary Supplements). *Food Allergen Labeling and Consumer Protection Act of 2004 (FALCPA)*. Accessed January 31, 2021. https://www.fda.gov/food/food-allergensgluten-free-guidance-documents-regulatory-information/food-allergen-labeling-and-consumer-protection-act-2004-falcpa
146. U.S. Food and Drug Administration. Food Labeling and Nutrition. *Gluten and Food Labeling*. Accessed January 31, 2021. https://www.fda.gov/food/nutrition-education-resources-materials/gluten-and-food-labeling
147. U.S. General Services Administration. eRulemaking Program Management Office. Regulations.gov. *Food Labeling: Revision of the Nutrition and Supplement Facts Labels.* Accessed January 31, 2021. https://beta.regulations.gov/document/FDA-2012-N-1210-0875
148. U.S. Food & Drug Administration. *The New and Improved Nutrition Facts Label—Key Changes.* Accessed January 31, 2021. https://www.fda.gov/media/135302/download
149. U.S. Food & Drug Administration. Food Labeling & Nutrition. *Label Claims for Conventional Foods and Dietary Supplements.* Accessed January 31, 2021. https://www.fda.gov/food/food-labeling-nutrition/label-claims-conventional-foods-and-dietary-supplements
150. U.S. Department of Health and Human Services. Food and Drug Administration, and Center for Food Safety and Applied Nutrition. *A Food Labeling Guide: Guidance for Industry (9. Appendix A: Definitions of Nutrient Content Claims, 10. Appendix B: Additional Requirements for Nutrient Content Claims)*. Accessed January 31, 2021. https://www.fda.gov/media/81606/download
151. U.S. Department of Health and Human Services. Food and Drug Administration and Center for Food Safety and Applied Nutrition. *A Food Labeling Guide: Guidance for Industry (11. Appendix C: Health Claims)*. Accessed January 31, 2021. https://www.fda.gov/media/81606/download
152. U.S. Department of Health and Human Services. Food and Drug Administration and Center for Food Safety and Applied Nutrition. *A Food Labeling Guide: Guidance for Industry (12. Appendix D: Qualified Health Claims)*. Accessed January 31, 2021. https://www.fda.gov/media/81606/download
153. U.S. Food & Drug Administration. Nutrition Education Resources & Materials. *The New Nutrition Facts Label*. Accessed January 31, 2021. https://www.fda.gov/food/nutrition-education-resources-materials/new-nutrition-facts-label