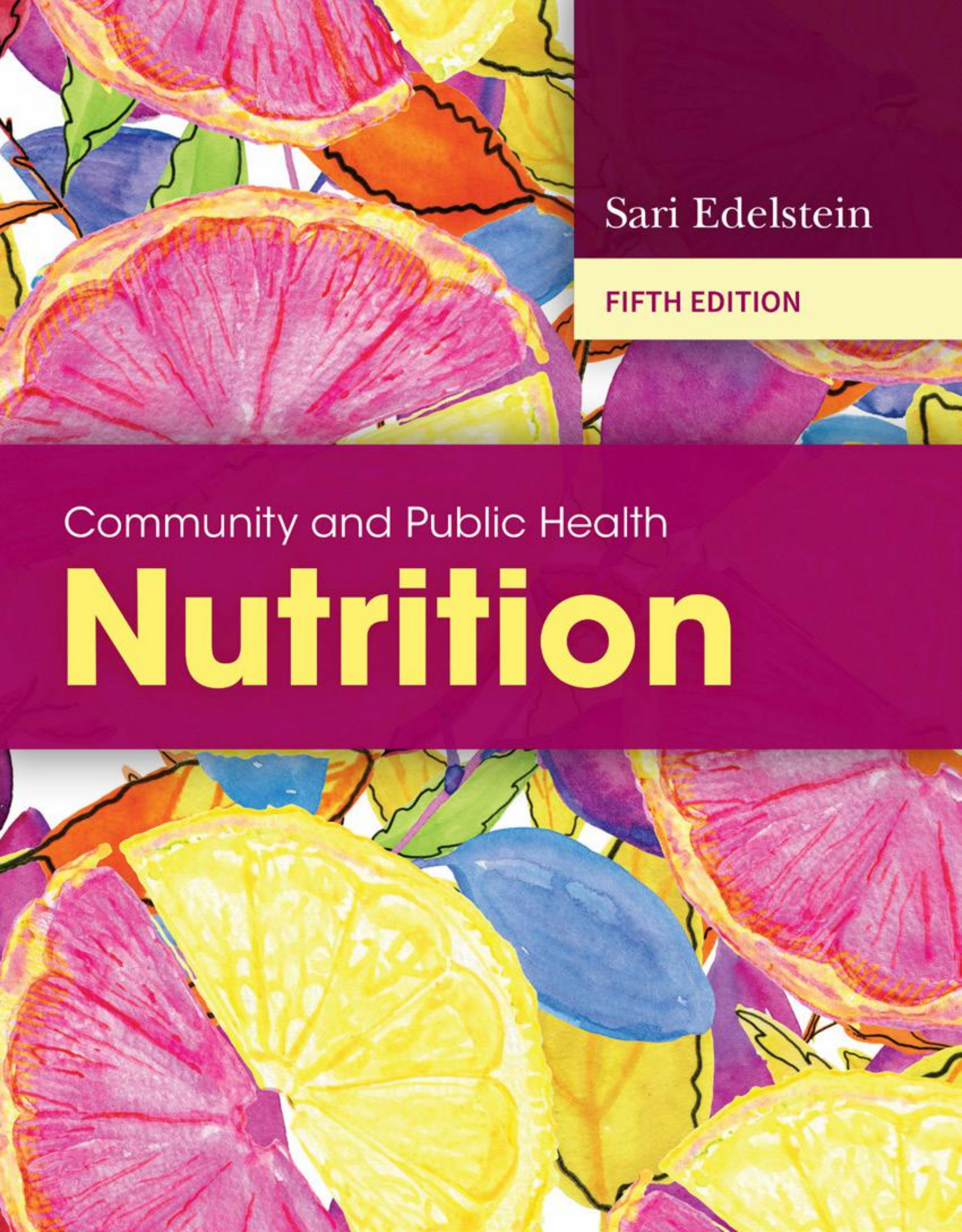
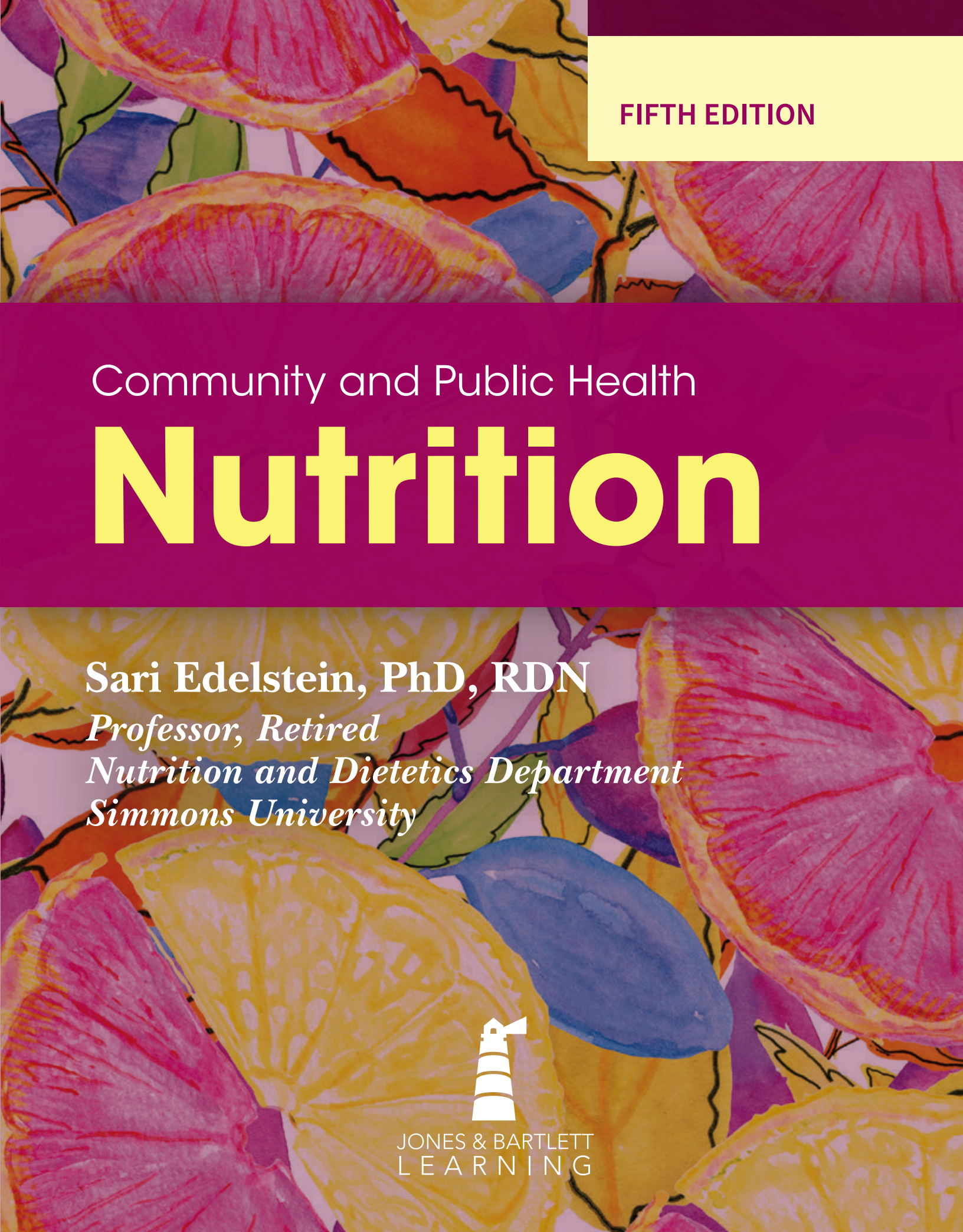


Sari Edelstein

FIFTH EDITION

Community and Public Health

Nutrition



FIFTH EDITION

Community and Public Health

Nutrition

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To many of my past students, who stepped up and wrote these chapters now that they are professionals in their own right.

Brief Contents

Contents

Preface

What Is Community and Public Health Nutrition?

Community and public health nutrition is a complex, multifaceted set of programs dedicated to improving the health of the population through improved nutrition. In more detail, community and public health nutrition primarily exists to:

- Improve the health of the whole population and teach high-risk subgroups within the population improved nutrition
- Emphasize health promotion and disease prevention through improved nutrition
- Provide integrated community efforts for improved nutrition with leadership demonstrated by local, state, and federal government offices

To accomplish these three primary elements of community and public health nutrition, the U.S. Public Health Service has delineated 10 Essential Public Health Service Functions.[1] Each of these 10 elements will assist the reader in understanding the steps that must be taken by public health professionals to bring about definitive qualitative and quantitative results.

1. Monitor health status to identify and solve community health problems
2. Identify and investigate the causes of health problems and health hazards in the community
3. Mobilize community partnerships and action to identify and solve health problems
4. Develop policies and plans that support individual and community health
5. Enforce laws and regulations that protect health and ensure safety
6. Link people to needed personal health services and assure the provision of health care when otherwise unavailable
7. Inform, educate, and empower people about health issues
8. Evaluate effectiveness, accessibility, and quality of personal and population-based health services
9. Assure a competent public health and personal healthcare workforce
10. Research for new insights and innovative solutions to health problems

When these 10 elements are expanded to full explanations, we create a compendium of information that mirrors the table of contents in this book. The organization of *Community and Public Health Nutrition, Fifth Edition* embraces the essential public health service functions.

Organization of This Text

The structure of *Community and Public Health Nutrition* has been completely reorganized not only to encompass public health nutrition but also to include community nutrition.

Part I, "Applying Nutrition in Community and Public Health," creates the necessary foundation for readers to understand community and public health nutrition. These chapters include:

- An explanation that community and public health goals are built on a foundation of sound research, wherein peer-reviewed studies provide the groundwork
- A journey through studying populations utilizing epidemiology and how problems and solutions are questioned and acted upon

Chapters 3 through 8 comprise Part II, "Shaping the Policies That Affect the Community and Public's Health," and Part III, "Assessing and Intervening in the Community's Nutrition Needs." These chapters illustrate the landscape of community and public health, including:

- The role of the local, state, and federal government in supporting community and public health nutrition
- How researchers and others determine the need for community and public health nutrition in areas of the United States
- How researchers determine the needs of each community and focus on its nutritional problems
- An explanation of how nutritional services are planned and evaluated for a community
- Changing the public's eating behavior

[1] www.cdc.gov/publichealthgateway/publichealthservices/essentialhealthservices.html

In Part IV, "Promoting the Public's Nutritional Health," Chapters 9 through 12, we strive to educate the reader about local, state, and federal programs that provide community and public health nutrition for those at risk. These include:

- Promoting maternal, infant, child, and adolescent nutrition
- Assessing and providing for adult nutrition
- Caring for older adults and their nutritional problems
- Explaining nutritional programs in public health

Part V, "Protecting the Public's Nutritional Health," delineates 21st century issues in providing safe and secure food supplies for the public. These include:

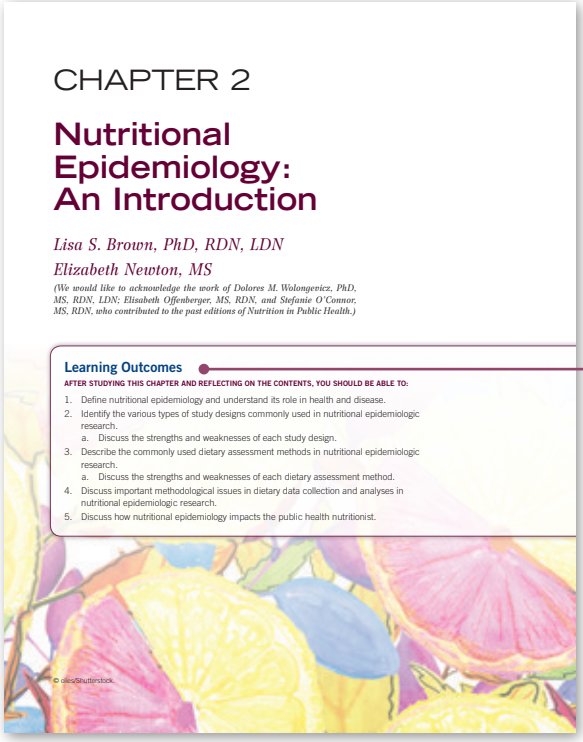
- Providing food security and adequate food access for the public
- Safeguarding and securing the food supply

Part VI, "Managing Programs," and Part VII, "Surviving in a Competitive World," address the administrative and managerial portion of community and public health nutrition and programs. These include:

- Grant writing for funding of community and public health nutrition programs
- Staffing, managing, and leading community and public health nutrition personnel
- Leveraging nutrition education through a community and public health team
- Networking for nutrition by earning administrative support
- Marketing nutrition programs and services
- Striving for excellence and envisioning the future

Features of This Text

An effort has been made to ensure that pedagogical features are consistent from chapter to chapter. At the beginning of each chapter, the reader will find the following:



CHAPTER 2

Nutritional Epidemiology: An Introduction

Lisa S. Brown, PhD, RDN, LDN

Elizabeth Newton, MS

(We would like to acknowledge the work of Dolores M. Wolongevicz, PhD, MS, RDN, LDN; Elisabeth Offenberger, MS, RDN, and Stefanie O'Connor, MS, RDN, who contributed to the past editions of Nutrition in Public Health.)

Learning Outcomes

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

1. Define nutritional epidemiology and understand its role in health and disease.
2. Identify the various types of study designs commonly used in nutritional epidemiologic research.
   a. Discuss the strengths and weaknesses of each study design.
3. Describe the commonly used dietary assessment methods in nutritional epidemiologic research.
   a. Discuss the strengths and weaknesses of each dietary assessment method.
4. Discuss important methodological issues in dietary data collection and analyses in nutritional epidemiologic research.
5. Discuss how nutritional epidemiology impacts the public health nutritionist.

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Learning Outcomes present the chapter's desired outcomes to readers.

Key Terms help the reader quickly identify critical new terms, with definitions included in the end-of-text Glossary.

Epidemiology assesses the occurrence of a disease within a set population. This field also looks at the factors that prevent and hasten the disease's development.

Nutritional epidemiology utilizes the processes of epidemiology to look at the influence of dietary factors on a disease or health condition in the population.

In the middle of each chapter, the reader will find the following:

Discussion Prompts provide practical application questions for readers to ponder and find solutions for as future community and public health personnel.

Discussion Prompt

Describe the factors that prevented the recognition of a nutrition link and good health. How did epidemiology change this thinking?

Strategy Tips encourage readers to take the chapter material further and call to action what health professionals should do in a situation.

Strategy Tips

Contacting elected officials

Vote in elections to influence who will represent your views in government.

- Join a professional association or advocacy group(s) that advocates for public health. Many voices are generally louder than one. Be active in the group and encourage policy involvement.
- Conflicts arise. Don't take them personally. Learn from your opponent's position; it may strengthen your own position. Accept that some people may reject you for your position on an issue.
- Write letters to the editor of the newspaper when you have a strong position on a health or nutrition issue.
- Identify and know your audience. Adjust your message to better target their concerns and needs.
- Be persistent. Learn from your own mistakes and move on with that knowledge to do a better job next time.
- Take the time to comment on policy proposals and changes. The government often requests written comments on new policies and policy changes. These requests for comments are printed in the Federal Register for comment periods of 30 to 90 days. This is one of those unusual times when someone is required to read your letter and comments. Federal employees are required to read and compile all comments received during a comment period. These compiled comments are then used to support approval, change, or rejection of proposed policies.

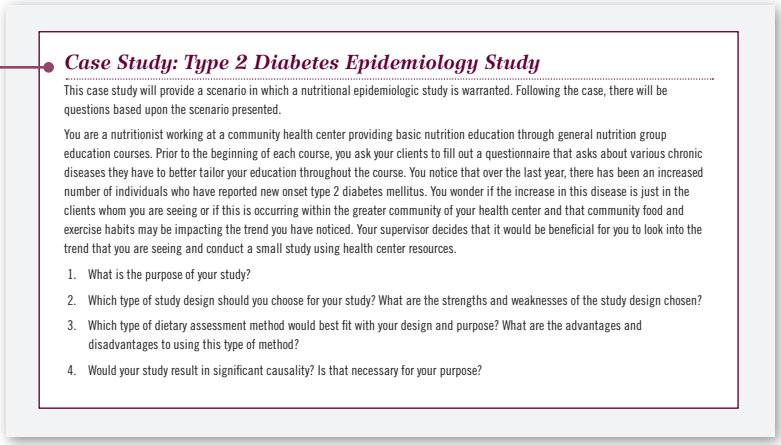
Pandemic Learning Opportunity asks the readers to recognize problem-solving situations that occurred during the pandemic for future use.

Pandemic Learning Opportunity

If epidemiologists were able to act faster than what occurred in 2021, how would the outcome change? Going further, how important is it to have a fully functioning epidemiology unit working in the United States?

At the end of each chapter, the reader will find the following:

Case Studies provide a real-world dimension to chapter content, illustrating how public health nutrition issues and programs can affect real people. Each chapter now has two case studies.

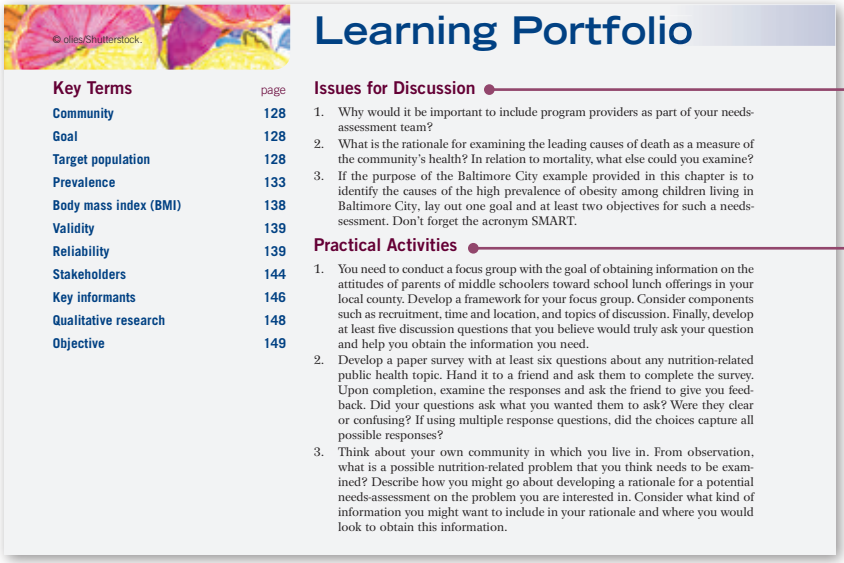


Case Study: Type 2 Diabetes Epidemiology Study

This case study will provide a scenario in which a nutritional epidemiologic study is warranted. Following the case, there will be questions based upon the scenario presented.

You are a nutritionist working at a community health center providing basic nutrition education through general nutrition group education courses. Prior to the beginning of each course, you ask your clients to fill out a questionnaire that asks about various chronic diseases they have to better tailor your education throughout the course. You notice that over the last year, there has been an increased number of individuals who have reported new onset type 2 diabetes mellitus. You wonder if the increase in this disease is just in the clients whom you are seeing or if this is occurring within the greater community of your health center and that community food and exercise habits may be impacting the trend you have noticed. Your supervisor decides that it would be beneficial for you to look into the trend that you are seeing and conduct a small study using health center resources.

1. What is the purpose of your study?
2. Which type of study design should you choose for your study? What are the strengths and weaknesses of the study design chosen?
3. Which type of dietary assessment method would best fit with your design and purpose? What are the advantages and disadvantages to using this type of method?
4. Would your study result in significant causality? Is that necessary for your purpose?



Issues for Discussion encourage readers to discuss topics relevant to the chapter with their peers.

Practical Activities suggest activities that allow readers to apply what has been learned in the chapter, either individually or as part of a group.

Online Resources direct readers to websites relevant to the chapter content.

Online Resources

1. Administration on aging: http://www.aoa.gov
2. American Association of Retired Persons: http://aarp.org
3. American Geriatrics Society: http://americangeriatrics.org
4. Centers for Medicare and Medicaid Services: http://cms.hhs.gov/
5. Meals on Wheels Association of America: https://www.mealsonwheelsamerica.org/
6. Mini Nutritional Assessment: https://www.mnaelderly.com/forms/mini/mna_mini_english.pdf
7. National Association of Nutrition and Aging Services Programs: http://www.nanasp.org
8. National Institute on Aging: https://www.nia.nih.gov/
9. National Institutes of Health Seniors Health: https://www.nia.nih.gov/health
10. Older Americans Act Nutrition Program: https://acl.gov/sites/default/files/news%202017-03/OAA-Nutrition_Programs_Fact_Sheet.pdf.
11. U.S. Food and Drug Administration – Food Safety for Older Adults: https://www.fda.gov/media/83744/download

These pedagogical features assist in bringing the chapter material to life as students will need to use critical thinking to solve public health nutrition problems through application.

New to this Edition

Community and Public Health Nutrition, Fifth Edition has maintained the cutting-edge relevance of previous editions, while adding several enhancements:

- New Box Features were created for this edition including **Discussion Prompts, Lessons Learned from the Pandemic**, and **Strategy Tips** which were developed to help the reader with critical thinking and practical application.
- **Additions to the Table of Contents**. The Table of Contents has added material to reflect the addition of community nutrition to each chapter. The text can now be fully utilized for both community nutrition and public health nutrition courses.
- **Thoroughly revised and in-depth content**. Each chapter has been updated and enhanced to give the reader a vast supply of background information and a full understanding of community and public health nutrition. In addition, new and expanded topics have been added to the *Fifth Edition* to reflect current community and public health issues. These include:
  - Updated *Dietary Guidelines for Americans*, *Healthy People 2030*, and other nutrition indexes
  - Updated community and federal nutrition policies and services
  - Updated approaches to disease prevention and new disease statistics, including current U.S. statistics and census information
  - Newly added grant-writing procedures
  - New, comprehensive, end-of-text Glossary
- **Added Case Studies**. Two case studies are now found at the end of each chapter, reinforcing key concepts by presenting real-life examples. An Answer Key for all case study questions is available for qualified instructors.
- A **Study Guide** is now provided Online featuring numerous activities for students to complete in writable PDFs.

Instructor and Student Resources

Qualified instructors can receive access to the full suite of instructor resources, including the following:

- Slides in PowerPoint format, featuring more than 300 slides
- Test Bank, containing 600 questions
- Study Guide containing the following for each chapter:
  - Learning Outcomes
  - Practical Activities
  - Matching Key Terms with Definitions
  - Additional Case Studies and their answers
  - Fill-in-the-blank Questions and their answers
  - Critical Thinking Questions
  - Issues for Discussion

Acknowledgments

The editor of *Community and Public Health Nutrition*, *Fifth Edition* would like to recognize the chapter contributors and the Jones & Bartlett Learning staff for their diligence and hard work to make this edition possible.

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PART I

Applying Nutrition in Community and Public Health

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, 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 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.

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.

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

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.

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.

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