“Research: Successful Approaches in Nutrition and Dietetics contains the collective knowledge of our field, with each chapter authored by distinguished nutrition and dietetics researchers. This newest edition will continue to serve as a reference and educational foundation for our profession.”

— Ashley Vargas, PhD, MPH, RDN, FAND, Health Scientist, Office of Disease Prevention, Office of the Director, National Institutes of Health; Chair, Academy of Nutrition and Dietetics Research Dietetic Practice Group, 2018–2019

For over 25 years, this highly respected resource has presented the evolving knowledge of the foremost research experts in the field of nutrition and dietetics. The fully revised fourth edition of Research: Successful Approaches in Nutrition and Dietetics addresses designing, executing, analyzing, and communicating modern nutrition research that is essential for today’s evidence-based practice. From formulating hypotheses, research questions, and study design to ethical research conduct, writing proposals, and securing funding, this reference builds a strong research foundation, making research accessible for all readers. Sections devoted to the key types of research and assessment methods used in the study of nutrition and dietetics offer in-depth coverage of new and different tools and methodologies, including:

- When and how to use qualitative research
- Observational and experimental research, including analytic nutrition epidemiology and guidelines for conducting clinical nutrition studies
- Integrative and translational research, including the value of systematic reviews and interdisciplinary research
- Evaluation and assessment methods, including survey research, dietary assessment methods, food composition analysis, appetite assessment, and more
- Research in expanding areas of practice—nutrigenomics, behavioral health, dietary supplements, foodservice management, community settings, integrative nutrition, and dietetics education.

Evaluation and application of research findings are also addressed in chapters on statistical analysis, presentation of research data, and bridging research results into practice.
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Editors

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Foreword

Research: Successful Approaches in Nutrition and Dietetics, now in its fourth edition, remains a touchstone for all nutrition and dietetics researchers. This text contains the collective knowledge of our field, with each chapter authored by a distinguished nutrition and dietetics researcher. This newest edition will continue to serve as a reference and educational foundation for our profession.

While the scientific method underpinning research has not changed in hundreds of years, the complexity of our research questions and research tools have increased appreciably. Professors Van Horn and Beto do an excellent job orienting readers to the full-spectrum of nutrition and dietetics research throughout this text, including clear indications of pros and cons for different tools and methodological approaches. Chapters 1 through 4 orient the reader, walk through the scientific method, describe how to obtain monetary support for research, and explain the ethical responsibility of researchers, respectively. The remaining chapters largely dive deeper into the array of different approaches, methods, and tools used in nutrition and dietetic research. This format easily allows the reader to simply choose topics of interest or to read through all topics for a more global understanding.

In 2017, the Academy of Nutrition and Dietetics celebrated its centennial, and, on behalf of the Research Dietetic Practice Group, I am beyond pleased to see the prominence of research within the Academy of Nutrition and Dietetics strategic plan. This is especially vital right now because research is more complex than ever and is being communicated to the public in smaller and smaller sound bites. Indeed, the Academy of Nutrition and Dietetics designated research as the first of four strategies to fulfill their mission to “Accelerate improvements in global health and well-being through food and nutrition.” For over 25 years the Academy of Nutrition and Dietetics has committed to publishing this text, which demonstrates the long-standing dedication of the Academy of Nutrition and Dietetics, and its membership, to quality research.

Ashley J. Vargas, PhD, MPH, RDN, FAND
Health Scientist, Office of Disease Prevention, Office of the Director, National Institutes of Health; Chair, Academy of Nutrition and Dietetics Research Dietetic Practice Group, 2018–2019
We are grateful to each of our talented authors. Their expertise is evident in these chapters, which provide the most current and credible information available in their respective areas of concentration. We highly respect these individuals for their hard work and creativity in presenting complex concepts in new and novel ways. We want to further give our appreciation to past authors whose contributions in earlier editions modelled certain topic areas.

We sincerely thank the Academy of Nutrition and Dietetics for supporting the development of this new edition. Specifically, the Publications, Resources, and Products team is recognized for its commitment to excellence, ongoing involvement, and dedication. Without them, this book could not have been produced.

We also wish to remember our former colleague and past editor of the Journal of the Academy of Nutrition and Dietetics, Elaine Monsen, PhD, RD, whose initiative launched the first edition of this book. Her commitment to teaching and training nutrition researchers has inspired countless investigators to take the tools and tips provided to design, implement, and publish remarkable findings and new discoveries.

Finally, we thank you, the readers, for your interest, scientific curiosity, and ambition. We encourage each of you to discover “successful approaches” to developing high impact nutrition research of your own!

Linda Van Horn, PhD, RDN
Judith Beto, PhD, RDN
About the Fourth Edition

The fourth edition of Research: Successful Approaches in Nutrition and Dietetics is a timely and comprehensive update on designing, conducting, and evaluating nutrition research. This text strategically targets nutrition students, their professors, and practitioners who seek a deeper understanding of the evidence base that forms nutrition policy and practical applications. There is an emphasis on the modern integration of nutrition science, epidemiology, clinical translational relevance and food-based practices. Advances in biostatistical analyses, biological mechanisms, and newly emerging biomarkers are encompasses throughout.

The book’s ten sections capture the excitement of research discovery, the importance of establishing a supportive research environment, and details specific to conducting observational, integrative, and translational research in the modern era.

Section 1 follows in the footsteps of the previous edition, laying a general foundation for the importance of discovery through research. Examples have been updated to give readers a glimpse of current research models to illustrate the main points.

Section 2 brings to the reader the most up-to-date information on advancing science through ethical research. Detailed information on writing proposals has been revised to feature the most current resources in grant writing and proposal funding resources.

Section 3 explores, in depth, the unique attributes of descriptive research with a new focus on efficiency in data collection.

Section 4 has been expanded to introduce the topic of consistency in study findings and includes new figures and illustrations to elaborate on clinical nutrition studies. Chapter 9 has been augmented to offer the latest in nutrition monitoring.

Section 5 includes a brand new chapter on bridging disciplinary boundaries and working on teams with members from varied backgrounds.

Section 6 incorporates key components relevant to evaluation and assessment methods in research, ranging from surveys to assessment methodology, as well as the importance of the food composition databases and dietary reference intakes that are essential to all aspects of nutrition research. A detailed and up-to-date review of existing biomarkers and how to apply them is included, as well as a specific focus on research involving appetite assessment.

Section 7 includes six chapters that are fundamental to the food, nutrition, and dietetics arena. New to this section is the subject of diet and human genetics, which is rapidly evolving. This topic is an essential component of understanding nutrition research in the modern era.

Section 8 concentrates on statistical applications that are vital to nutrition research and an invaluable component of understanding as well as writing nutrition research papers that merit publication in high impact journals.

Section 9 further describes best approaches to illustrate, evaluate, and integrate nutrition research data within the development of subsequent studies and their interpretation.

Finally, Section 10 brings it all together in the process of applying research in practice. The importance of community-based research in implementing public health benefits is the new culminating chapter to further emphasize applied-side nutrition and dietetics.

Authors who have contributed their time and talents to the fourth edition are uniquely qualified to address each topic, and their individual areas of expertise are well recognized and respected in the published literature. This text aims to enhance, expand, and energize readers to embrace the excitement of nutrition research, ignite new ideas and approaches, and achieve a better understanding of the importance of diet and nutrition in health throughout the life course.
SECTION 1

An Introduction to Discovery Through Research in Nutrition and Dietetics
Chapter 1
Advancing the Research Continuum
Forces for Research
Advancing Your Own Research

Chapter 2
Building the Research Foundation: The Research Question and Study Design
Designing a Research Study
Descriptive Research Designs
Experimental Study Designs
(Randomized-Trials)
Prospective (Cohort, Follow-Up) Studies
Case-Control Studies
LEARNING OBJECTIVES

1. Introduce the overall premise of this book.
2. Highlight key topics and research elements addressed.
3. Encourage readers, whether novice or experienced, to apply these principles and strategies to their own research as they move forward with their careers.

Nutrition research is fundamental to the evidence-based practice of nutrition and dietetics. Well-designed, carefully executed, quality-controlled studies offer insights and breakthroughs that drive the field forward. Research fosters objective measurement of complex environments and demands rigorous evaluation of procedures, treatments and outcomes. Through research, associations can be identified, hypotheses tested, programs compared, and protocols validated. Research documents practice, monitors approaches, ensures credibility, and assesses cost-effectiveness. The strength of a discipline, whether in health sciences or management, is characterized by the quality and quantity of evidence in its research base. Strong and consistent research is essential to a vibrant profession, pending active involvement of professionals in keeping abreast of the dynamic findings.
FORCES FOR RESEARCH

Monsen\(^1\) identified driving forces that continue to influence nutrition research today. These include recognizing unexpected findings, extending existing data, posing point-counterpoint comparisons, and responding to socioeconomic, political, and behavioral influences of a culturally diverse environment. Included in modern applications of research are the numerous influences conferred by social media and the rapid-fire communication of results that can undermine careful consideration of unintended consequences.

Recognizing the Unexpected

An exciting by-product of a research study is sometimes the hidden finding that launches new topic areas of study. This is more commonly known as the “Aha!” moment. Discovery of the first vitamin is a clear example. In the 1700s, a British naval surgeon, James Lind, gave a great deal of thought to the vast occurrence of scurvy among English sailors. The disease was particularly rampant on long voyages. In 1747, Lind completed the first controlled dietary study where he proved that citrus fruits cured scurvy. Six years later Lind\(^2\) published his treatise, and in 1796, 43 years after his publication, the British navy officially introduced lemon juice as a prophylactic against scurvy.

More than a century later, in 1906, the concept of developing accessory food factors was introduced. In 1932, 185 years after Lind’s first controlled study, crystalline vitamin C was prepared from lemon juice. While no one can plan for a breakthrough (such as the dietary importance of citrus fruit), investigators should always be alert for the unexpected. For example, the findings from the Women’s Health Initiative reported completely unexpected results regarding the use of progestin-containing hormone therapy, which was long considered protective; the report found that progestin was adversely associated with increased risk of postmenopausal breast cancer.\(^3\)\(^-\)\(^5\) These results changed the course of clinical postmenopausal management almost overnight. From 1988 through 1994, 44% of American women reported using hormone therapy, but this was reduced to 4.7% by 2010, with ongoing recommendations against its use in 2017 by the US Preventive Services Task Force.\(^6\)

Extending Existing Data

Going beyond what is known to discover what is not known remains a compelling force of research. Another classic example is discovery of the second vitamin. When the idea of accessory food factors was introduced to the scientific community, researchers eagerly devoted attention to ascertaining whether other important food factors existed and their sources and functions. From 1913 to 1916, research teams led by McCullum et al\(^7\)\(^-\)\(^8\) observed and isolated components from foods that they termed Fat Soluble A and Water Soluble B. Shortly thereafter, Fat Soluble A was partitioned into vitamins A, D, E, and K, and Water Soluble B developed into the long series of B vitamins.\(^9\) This search for accessory food factors was a highly productive extension of the earlier discovery of vitamin C.

A more current example is the study of glycemic index and glycemic load. While the relevance and practical application of these two factors in regards to development of insulin resistance or type 2 diabetes remains somewhat mixed,\(^10\)\(^-\)\(^11\) awareness of the potential role of these factors in impacting postprandial glucose/insulin response opened a new and compelling area for nutrition research.\(^12\)\(^-\)\(^14\) The epidemiologic relevance of a topic like this and its importance in setting the stage for next generation research are addressed more extensively in Chapters 5 and 7.

One of the trending topics of today centers on the growing awareness of biomarkers, which can help provide objective measures of nutrient intake and help to identify biological pathways and processes related to digestion, absorption, and metabolism. Chapters 16 and 21 are particularly relevant to this topic and offer insights into how best to cross-check diet intake with metabolic outcomes.

Also, with the increasing interest in precision medicine and now precision nutrition, nutrigenomics and the myriad of diet-gene interactions are likely to become even more important to the understanding of prevention and diet therapy to meet the
needs of the individual, including questions regarding weight control. Chapter 19 is devoted to this topic and raises many hypothesis-generating research questions.

**Point-Counterpoint Comparisons**

The point-counterpoint concept involves actions and reactions. A current example is the explosion of “functional foods,” including prebiotics and probiotics that have been developed by the food industry, presumably to conveniently meet nutrient needs of busy people without imposing the hassle of buying and preparing raw ingredients. Whether these foods and products prove helpful or harmful (perhaps due to extra calories, sugar, salt, or other factors) remains controversial, but the presence of these products continues to have a growing influence on the modern diet. The knowledge gap associated with their risk-benefit ratios—especially the gap based on age, sex, health status, and pharmacological influences—requires future study.

**Responding to the Socioeconomic, Political, and Culturally Diverse Environment**

The Special Supplemental Food Program for Women, Infants and Children (WIC) represents an outstanding response to the socioeconomic and political environment. Evaluation and documentation of the WIC program and innovative new approaches are among the prime reasons that the program has been so successful. Increasing cultural diversity and the accompanying increase in rates of homelessness raise challenges related to economic opportunity and adequate nutrition for underserved pregnant women. Qualitative research on these and associated topics is addressed in Chapter 6. Applied research on these topics offers promise for ameliorating these difficult problems.

**Research Now**

Nutrition research has never been more exciting or more challenging. The forces of research are ever influencing new studies and their findings. Registered Dietitian Nutritionists (RDNs) are encouraged to take an active role in designing studies, both basic science and clinical, to document the benefits of nutrition in prevention and treatment of disease. Applied translational research is especially valued; it takes results from bench to bedside and even curbside, offering timely community health benefits derived from well executed experimental and clinical designs. Chapters 11, 18, 29, and 30 are especially relevant in this area. This book offers a wealth of tools and techniques for designing nutrition research studies of your own. Here are a few of the basics to get you started.

**Prepare the Research Protocol**

A research protocol is essential to direct the study in a manner that ensures meaningful results. The research protocol includes (1) specific aims and hypotheses that pose focused and concisely stated research questions, (2) a comprehensive literature review, (3) the merit and potential value or innovations of the research, and (4) the appropriate research design to adequately test the hypotheses. Research design includes the study methods, data collection, and decisive statistical analyses to be used to test the hypotheses. See Chapters 8 through 10.

Research proposals must conform to a funding agency’s requirements, as stated in its guidelines. Chapter 4 provides detailed guidance on securing funding. Many private and public agencies model their guidelines after those of the National Institutes of Health (NIH). Proposals are typically submitted electronically, requiring the authors to pay careful attention to all details, including the due date and time.

**Conduct the Pilot Study to Produce Preliminary Data**

A pilot study to generate preliminary results is essential in most NIH studies to demonstrate the feasibility and merit of the proposed study design and methodology. Testing instruments and validated methods permits researchers to make adjustments before launching the study, thereby assuring that data collection is efficient and accurate. All data collection needs justification. Providing preliminary data and demonstrating experience gained from the
pilot study are crucial to successful review and funding for the proposed project. See Chapters 2, 8, 9, 12, and 13.

Ensure Ethical Research

Institutional Review Board (IRB) approval is required prior to initiating all research studies. Researchers must follow ethical procedures in all aspects of the design and conduct of their research. Everything, ranging from the choice of topic, to the samples collected, to the interventions designed, to the data collected, to—perhaps most important of all—gaining informed consent, must be considered ethical as judged by IRB approval. Data analyses and reporting of data are likewise subject to scrutiny. Chapter 3 provides a more detailed discussion.

These investigations must meet ethical guidelines to protect the rights, privacy, and welfare of the individuals. The Declaration of Helsinki, drafted in 1964 by the World Medical Association, serves as the basis for the ethical guidelines that are now detailed regulations issued by governmental agencies, such as the NIH. The local IRB is required to review all investigations using human subjects to ensure ethical conduct and evaluate potential risks and benefits.

As part of informed consent, the investigator must explain to potential participants the nature of the study, including the possible risks and discomforts they may experience. Confidentiality of all data is mandated by all review boards. Specific elements to be included in the informed consent procedure, including written and verbal descriptions, are designated by the local IRB. See Chapters 3 and 9.

Validity, Accuracy, Reliability, and Precision

Qualities critical to all research are validity, accuracy, and precision. Use of validated instruments is essential to ensuring accuracy, reliability, and precision of the data and the results. The National Cancer Institute has developed a highly comprehensive Dietary Assessment Primer (https://dietassessmentprimer.cancer.gov) that provides detailed definitions and examples of these and other aspects of nutrition research as follows:

- **Validity**: The degree to which a tool measures what it claims to measure.
- **Accuracy**: The degree of closeness of measurements of a quantity to that quantity’s true value.
- **Precision**: The degree to which repeated measurements under unchanged conditions show the same results.

Sensitivity and Specificity

The choice of a single cut point to categorize individuals may not always be clear when the test yields a continuous scale of values. A cut point selected to maximize sensitivity will unavoidably cause the test to be less specific. The selection of an appropriate cut point is aided by use of graph plotting true-positive against false-positive ratios, known as the receiver operating characteristic (ROC) curve. The ROC curve graphically displays the reciprocal relationship between sensitivity and specificity for values of a test measured on a continuous scale, and it allows investigators to choose a cut-point that maximizes the performance of the test for the needed levels of sensitivity, specificity, or both. See Chapters 17, 25, 28, for more detailed explanations.

National Health and Nutrition Examination Survey (NHANES) I, II, and III provide countless examples of valid survey testing. The mean intakes of certain vitamins by age and gender are useful for determining areas of weakness in the population’s diet and indicating possible policies to apply. Limitations in survey results often include low response rate and cross-sectional design. Randomized clinical trials and longitudinal cohort studies are considered more robust, but these also have limitations that require further considerations. Chapters 8, 9, 12, 13, and 14 offer further discussion and insights regarding these issues.

Researchers must also use discretion in applying inferential statistical tests to data from survey research. Because survey studies are designed to be descriptive rather than analytic, formal tests of hypotheses are undertaken after the data are viewed,
and the test result is likely to be biased toward a spurious statistically significant result. Such inferential tests should be regarded as exploratory and useful in generating questions for future analytic studies. Chapters 21 and 25 offer further explanation of this topic.

ADVANCING YOUR OWN RESEARCH

The topics listed in this chapter represent only a few of the key aspects of nutrition research that are addressed in this book. The possibilities are endless, but the competitive nature of grant reviews and funding constraints often steer research proposals towards filling high priority knowledge gaps identified by the funding agencies. A newly convened Dietary Guidelines for Americans Advisory Committee, with the assistance of the Nutrition Evidence Library, conducts systematic reviews of newly published nutrition research every 5 years as part of the process for developing the next edition of the Dietary Guidelines for Americans. Savvy researchers can begin with the end in mind by reviewing these priority areas and carefully developing testable hypotheses that will address them. Consider the population, intervention, comparator, and outcome (PICO) that form the criteria used in systematic reviews. Formulation of study questions, specific aims, and validated outcome measures that are consistent with these criteria can often make or break an investigator’s chances of achieving a fundable score.

CONCLUSION

In this era, massive use of social media, blogs, tweets, and crowdsourcing to derive answers to countless questions has influenced public perception of what to believe and how to behave. The importance of evidence-based science to provide sound answers and guide public policy, including what to eat, is paramount. Take these tools and go for it!

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