National Institutes of Health

NUTRITION RESEARCH REPORT

National Institutes of Health

2022–2023

DPCPSI Director's Message

Good nutrition goes beyond healthy physical development and basic survival—it is integral to disease prevention, well-being, and longevity. Nutrition affects an individual's mental and physical state and, by extension, their work performance and livelihood. We must also recognize nutrition's broad impact on individual and community health, including the associated socioeconomic effects.

When the *2020–2030 Strategic Plan for NIH Nutrition Research* was released in May 2020, the unifying vision of "Precision Nutrition" outlined many factors of influence. In addition to food, these factors included an individual's dietary habits, genetic background, health status, microbiome, metabolism, food and physical environments, physical activity, socioeconomics, and psychosocial characteristics. Developing more targeted and effective interventions to improve and maintain health in the increasingly diverse U.S. population requires an understanding of the interrelationships among these factors. Ongoing nutrition science research at the National Institutes of Health (NIH) is key to discovering those connections.

The *NIH Nutrition Research Report, Fiscal Years 2022–2023* provides a window into the ongoing nutrition health efforts at NIH, recent scientific advancements, and key research findings. The NIH Institutes, Centers, and Offices are essential partners with other key federal collaborators in the research being conducted, the scientific discoveries being made, and the drive for behavioral and societal change that will enhance health for all.

Scientific advancements are happening at the speed of light in biomedical research. NIH takes immense pride in being a world leader in fostering this progress, reflecting our shared commitment to advance biomedical and behavioral science through cross-cutting, novel solutions. When it comes to collaborative and innovative ways to approach nutrition research, NIH is poised to lead the way.

I congratulate my colleagues on the work done to date to advance nutrition research and encourage their efforts to continue to explore beyond the current knowledge base and expand the evidence available. I look forward to a future of better health for all based on impactful nutrition research and actionable findings that translate to everyday life.

Tara A. Schwetz, Ph.D.

NIH Deputy Director for Program Coordination, Planning, and Strategic Initiatives

Director, Division of Program Coordination, Planning, and Strategic Initiatives, Office of the Director

National Institutes of Health

ONR Director's Message

Nutrition is everyone's business—not only because everyone eats but also because food weaves a thread through the very fabric of human culture, history, family, and memory. Nutrition research is also a major thread at every NIH Institute, Center, and Office (ICO). The biology of nutrition connects food to health; it touches every cell and every system in our bodies at every age and every stage throughout the lifespan.

Globally, we are facing an urgent nutrition-related health crisis. Malnutrition is now the leading cause of morbidity and mortality in the world. In the United States, suboptimal nutrition threatens our public health, economy, and national security and disproportionally affects those with lower incomes and educational attainment, those in rural communities and Tribal reservations, and those from traditionally marginalized racial and ethnic groups. One in three individuals on this planet suffers from some form of malnutrition, and many suffer from multiple forms simultaneously. Malnutrition affects an individual's ability to learn and grow to their full potential, creating a lifelong malady that reverberates beyond the immediate family and impacts the health of future generations.

As Director of the NIH Office of Nutrition Research (ONR), I appreciate the complexity of these and future challenges. Moving forward, we need to revolutionize how nutrition science is perceived and conducted and look beyond the current knowledge base that focuses on nutrients through biochemical and chemical studies. This means developing new tools and resources that inform nutrition science on a broader basis. ONR is taking steps in that direction by approaching nutrition holistically and viewing nutritional status as a biological variable and nutrition as part of a complex biological system. Factors involved in this system include the food we grow, buy, and eat, in addition to such diverse factors as household income, educational status, the food supply, and climate variations. Together, this system is best described as a nutritional ecology. Expanding the concept of nutrition from a one-dimensional construct (food-focused) to an ecological system of moving parts not only creates a more accurate picture but also introduces a wealth of research opportunities that can address persistent multidimensional problems that extend far beyond food.

Everyone has a stake in the design and outcome of nutrition research. Effective programs and policies need to be informed by solid science. For example, how do we approach nutritional assessment? How do we integrate the nutritional ecology into the nutrition care continuum? Answering these questions has the potential to transform how nutrition science is done. ONR is leading the effort to move the domestic and global nutrition research agenda forward via its role as a service provider, technical resource, and coordinator of the nutrition agenda across the ICOs. Through planning workshops, leveraging the Nutrition Research Coordinating Committee, and working with the ICOs and other federal partners through several thematic working groups, ONR is striving to achieve solutions for the urgent nutrition-related health crisis. ONR's leadership role on the Interagency Committee on Human Nutrition Research and its involvement with the Global Nutrition Coordination Plan have also been instrumental in advancing nutrition science across the United States and the world. This is our moment to generate the evidence that will change the lives of individuals, families, communities, and nations. It's time to recognize nutrition as a vital element in the research enterprise and a central driver of our health.

Andrew A. Bremer, M.D., Ph.D., M.A.S.

Director, Office of Nutrition Research

Division of Program Coordination, Planning, and Strategic Initiatives, Office of the Director

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I. Executive Summary

The mission of the National Institutes of Health (NIH) is to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability. NIH supports and conducts a broad array of transformative and impactful research studies to better understand nutrition and how it relates to human health and disease. This research focuses on understanding how nutrients and food components impact health and well-being throughout the lifespan. It also includes research studies to better understand the nutritional ecology and the effects of behavior, including eating and food choice, socioeconomic factors, and environmental exposures on an individual's nutritional status.

The NIH Nutrition Research Report summarizes nutrition research and training activities supported and conducted by NIH in Fiscal Years 2022 (FY22) and 2023 (FY23). This report was compiled and produced by the NIH Office of Nutrition Research (ONR), which is located in the Division of Program Coordination, Planning, and Strategic Initiatives in the NIH Office of the Director. ONR leads NIH-wide strategic planning and development of nutrition research and training initiatives.

NIH's total investment in nutrition-related research and training was approximately $2.1 billion in FY22 and $2.2 billion in FY23. Nutrition research and training funding increased by approximately $165.6 million (8 percent) from FY21 to FY23. Overall, funding increased approximately $675.7 million—a 43.5 percent overall increase—from FY14 to FY23 (Source: Categorical Spending—Nutrition, NIH Research Portfolio Online Reporting Tools [RePORT]). While the total amount of NIH funding for nutrition research and training has increased from FY19 to FY23 (in current dollars not adjusted for inflation), the percentage of NIH expenditures for nutrition research and training has decreased from 4.90 percent to 4.07 percent, respectively (Table 1). Approximately half of the nutrition-related projects in FY22 and FY23 were related to prevention or obesity (Figure 1).

NIH-supported nutrition research has led to several important discoveries. Many of these findings are announced in NIH News Releases or published in *NIH Research Matters*, a biweekly update of NIH research highlights from the NIH Office of Communications and Public Liaison. Highlights related to nutrition from FY22 to FY23 include the following:

- Dietary fat restriction affects brain reward regions: Researchers led by NIH's National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) Intramural Research Program (IRP) examined how restricting dietary fat or carbohydrates in humans with obesity affected brain activity. The results suggest that dietary fat restriction, but not carbohydrate restriction, modulates activity in brain-reward regions and affects food choice in ways that may hamper diet adherence.
- Fiber in diet linked to cancer immunotherapy response: Researchers led by NIH's National Cancer Institute (NCI) found that every 5-gram increase in daily fiber intake corresponded to a 30 percent lower risk of cancer progression or death.
- How diet may disrupt gut microbes to promote weight gain: NIH-funded researchers carefully studied the impact of fat and sugar in the diets of animals. The results emphasized that a complex interaction between diet, gut microbiota, and the immune system may play a key role in the development of obesity, metabolic syndrome, type 2 diabetes, and other conditions.
- Immune response to eating chitin linked to better health: An NIH-funded research team found in an animal study that the immune response to chitin may increase production of digestive enzymes and improve overall digestion and could be a potential therapeutic target for obesity and other metabolic diseases.

Nutrition-related scientific meetings, workshops, seminars, and symposia play a key role in the advancement of nutrition science by providing an opportunity to identify critical research gaps and scientific priorities, as well as disseminate research findings to the scientific community and the public. During FY22 and FY23, NIH sponsored several nutrition-related events, including the following:

- NIH Workshop on Multigenerational Nutrition Influences on Health and Disease, Day 1 and Day 2
- Malnutrition in Clinical Settings: Research Gaps and Opportunities Workshop

» Pathways to Prevention (P2P) Program: Nutrition as Prevention for Improved Cancer Health Outcomes

» Lessons Learned from Global Food and Nutrition Insecurity

NIH and governmentwide collaborations and public–private partnerships were critical to the development of nutrition-related research, strategic planning, and technology transfer initiatives during FY22 and FY23. These collaborations are critical to effectively utilize resources and harmonize the federal nutrition research agenda. Examples of such collaborations include the Interagency Committee on Human Nutrition Research, the National Collaborative on Childhood Obesity Research, the National Health and Nutrition Examination Survey, the Early Intervention to Promote Cardiovascular Health of Mothers and Children Program, and the NIH Nutrition Research Coordinating Committee.

NIH is committed to fostering innovative research and training to advance the field of nutrition science, with the goal of promoting and improving health. Each NIH institute, center, and office (ICO) plays an integral role in accomplishing this mission, and each has shared its research directions as they pertain to nutrition. This comprehensive report serves to be informative and to stimulate new ideas and discoveries.

II. Introduction

The National Institutes of Health (NIH), part of the U.S. Department of Health and Human Services (HHS), is the nation's medical research agency. NIH is made up of 27 Institutes and Centers (ICs), each with a research agenda that often focuses on specific diseases or body systems. NIH supports biomedical and behavioral research and training in nutrition as it relates to human development, health maintenance, disease prevention, and disease treatment.

Nutrition is a factor in many diseases and an integral part of overall health, development, and well-being. As a result, research interests in the nutritional sciences extend far beyond those of a single institute. Biomedical and behavioral nutrition research and training in fiscal year 2022 (FY22) and FY23 was supported by 24 NIH ICs and the NIH Office of the Director.

The NIH nutrition research portfolio includes extramural and intramural research, as well as research training programs. In FY23, 83 percent of the nutrition research portfolio encompassed extramural research, conducted by hundreds of institutions in the United States and in several countries across the world. Many of the research projects funded by NIH are based on ideas developed by individual investigators from institutions of higher education, independent hospitals, and other research organizations. Most of the intramural research was performed in laboratories on the NIH campus in Bethesda, Maryland—including the Clinical Center. NIH also has research facilities throughout the country.

III. Office of Nutrition Research

The mission of the NIH Office of Nutrition Research (ONR) is to advance nutrition science to promote health across the lifespan and to support the development of evidence-based, equitable, context-specific, culturally appropriate, resilient, and sustainable solutions to reduce the burdens of diet-related diseases and health disparities. To this end, ONR:

- Coordinates implementation of the 2020–2030 Strategic Plan for NIH Nutrition Research
- Identifies research projects that deserve expanded effort and support by NIH ICs
- Develops, leads, and manages NIH-wide nutrition research projects in collaboration with the ICs
- Represents NIH on intradepartmental or interagency committees on nutrition research and related policy issues
- Advises NIH leadership and other key officials on matters relating to research on nutrition

Andrew Bremer, M.D., Ph.D., M.A.S. was appointed Director of ONR in September 2023. He works collaboratively with the NIH ICOs, as well as other federal and nonfederal partners, to advance and coordinate nutrition research.

RESEARCH DIRECTIONS

ONR leads NIH and the U.S. government and other partners in stimulating actionable and solution-focused research to address key elements of the domestic and global nutrition enterprise so that there is an evidence base to support the implementation of context-specific, equitable, culturally appropriate, resilient, and sustainable solutions addressing priority diet, nutrition, and health challenges.

The Office coordinates efforts across NIH and the U.S. government in the nutrition research space, provides service and technical assistance, and strives to advance nutrition science from a translational perspective. Areas of focus include:

- Enhancing precision in nutrition science (from assessment to attribution to interventions–utilizing the conceptual framework of a nutritional ecology and appreciating nutritional status as a fundamental biological variable that is both an input and outcome of health and disease)
- Nutrition across the lifespan (with particular attention on assessing and optimizing nutrition in each stage of the life course)
- Nutrition and the environment (addressing the reciprocal relationships of climate/environmental changes with food systems, planetary health, and human health)

KEY ACHIEVEMENTS

Advanced Training in Artificial Intelligence for Precision Nutrition Science Research

ONR leads the Advanced Training in Artificial Intelligence for Precision Nutrition (AIPrN) Science Research Institutional Research Training Programs (RFA-OD-22-027), which aim to diversify and expand the nutrition science workforce by equipping it to apply artificial intelligence/machine learning (AI/ML) to analyze large and complex data sets, such as those within the *All of Us* Researcher Workbench. The ultimate goal of these programs is to tackle challenges in biomedical science to reduce diet-related diseases and health disparities. These training programs provide graduate students and postdoctoral fellows with interdisciplinary research training in AI and precision nutrition that includes ML, systems biology, systems science, big data, and computational analytics. These programs also support NIH diversity, equity, inclusion, and accessibility (DEIA) goals by emphasizing the importance of inclusive research environments and diversity in the backgrounds of trainees and mentors.

With the support of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD), National Institute on Minority Health and Health Disparities (NIMHD), Office of Dietary Supplements (ODS), and Office of Data Science Strategy (ODSS), AIPrN awards were made in FY 2023 to four different universities:

- Arizona State University—Tempe Campus, Interdisciplinary Systems-based Training for Precision Nutrition, T32DK137525
- Cornell University, Artificial Intelligence and Precision Nutrition Training Program, T32HD113301
- Prairie View Agricultural and Mechanical University, Increasing and Diversifying Future AI-Precision Nutrition Research Workforce to Promote Nutrition Health Equity among Underserved Populations, T32MD018933
- University of Hawaii at Manoa, The Hawaii Advanced Training in Artificial Intelligence for Precision Nutrition Science Research, T32DK137523

Food Is Medicine

The Food is Medicine Networks and Centers of Excellence Program is an ONR-led, NIH-wide, nutrition-focused initiative. A lack of good nutrition is the number one driver of poor health outcomes in the United States. Rates of obesity and other diet-related diseases are skyrocketing, and poor diet quality is now the leading risk factor for death in the U.S. Poor diets also exacerbate health inequities, as exemplified by individuals with lower incomes, living in rural communities, and from historically marginalized racial and ethnic groups being most affected. Moreover, poor diets are harming the United States economy, in that the combined health care spending and lost productivity from poor diets costs over $1 trillion each year. Yet a focus on nutrition is currently missing in the health care system, which in large part explains the rising disease burdens, costs, and inequities in diet-related chronic diseases. The Food is Medicine Centers of Excellence Program will specifically address this gap by supporting programs that respond to the critical link between diet and health with the provision of healthy food, as well as having health care organizations as their nexus. The program will also address current barriers that exist both in communities and within health care systems that severely limit the ability to reduce obesity and other diet-related diseases (e.g., cardiovascular disease, cancer, and diabetes). Significantly, this innovative program will further support implementation science and intervention and health quality research on culturally sensitive Food is Medicine initiatives and other strategies to improve public health and address barriers to care.

Nutrition for Precision Health, powered by the *All of Us* Research Program

ONR is a scientific lead for the Nutrition for Precision Health (NPH), powered by the *All of Us* Research Program. The goal of NPH is to describe and better understand variations in how different people respond to diet, with the aim of developing algorithms that predict individual responses to food and dietary patterns. NPH is building on recent advances in biomedical science, including AI and microbiome research, as well as the infrastructure and large, diverse groups of participants from the *All of Us* Research Program. These advances provide unprecedented opportunities to generate new data to provide insight into precision nutrition, and the scale and diversity of the participant population sets NPH apart from other nutrition studies. NPH launched in FY 2022, with awards to support clinical centers, data modeling and bioinformatics, multiple biological assays, and coordination efforts. The study began enrolling participants in 2023 from 14 sites across the United States, with the goal of engaging 8,000 participants

from diverse backgrounds. Recruitment for NPH is ongoing, and the study's findings may allow health care providers to offer more customized nutrition guidance to improve individuals' overall health. Over the next several years, NPH will conduct nutrition studies involving large numbers of diverse participants, perform analyses on biological specimens collected from individuals in response to various foods and dietary patterns, develop computational modeling and algorithms, and share data with the research community. NIH anticipates that these efforts will lead to more personalized nutrition guidance and improved health. NPH is supported by the NIH Common Fund and managed as a partnership with the *All of Us* Research Program and several ICOs that serve on the NIH-wide Working Group that provides oversight of the program.

Stimulating Research to Understand and Address Hunger, Food, and Nutrition Insecurity

The purpose of this ONR-led notice of special interest (NOSI, NOT-OD-22-135) focused on stimulating research to understand and address hunger, food, and nutrition insecurity is to encourage research on the efficacy of interventions that address nutrition security and the mechanisms of food insecurity on a variety of health outcomes. This NOSI supports research projects to advance nutrition equity, including (1) the development and testing of interventions, innovative programs, and natural experiments to address food insecurity and neighborhood-level access to healthy and affordable foods; (2) research to understand the mechanisms and pathways between food insecurity and neighborhood food environments on well-being and health and various health outcomes; and, (3) studies to develop and validate tools to measure nutrition insecurity and food insecurity.

IV. NIH Nutrition Research and Funding

OVERVIEW

NIH is the leader in federally supported nutrition research and training. In FY21, FY22, and FY23, NIH provided a total of $2.1, $2.1, and $2.2 billion, respectively, toward these efforts. These amounts represent the combined individual contributions of 24 NIH ICs and the NIH Office of the Director. In FY23, NIH funded nutrition-related research in 50 states, the District of Columbia, Puerto Rico, and eight foreign countries. NIH supported approximately 2,200 nutrition-related clinical studies in FY23.

NIH NUTRITION RESEARCH REPORTING

The FY22 and FY23 nutrition research and training information in this report—including grants, contracts, and other funding mechanisms—was obtained using the NIH Research Portfolio Online Reporting Tools (RePORT) and NIH RePORT Expenditures and Results (RePORTER) systems, which are publicly available open-source databases. Additional information about these databases, as well as the methodology for how the data within this report were obtained, are available in Appendix A.

NUTRITION RESEARCH AND TRAINING EXPENDITURES

Trends: FY19–FY23

As a percentage of total NIH spending, nutrition research funding has been stable at approximately 5 percent since FY15. Table 1 shows total NIH nutrition research and training support in current and constant dollars. Actual obligations for nutrition research and training by the ICs for FY21 to FY23 are shown in Table 2. NIH nutrition research funding increased by more than $165.6 million (8 percent) from FY21 to FY23, but the increase was not a uniform trend across individual ICs.

The most recent nutrition research and training expenditures for the ICs in FY23 are shown in Table 3 as total funding amounts and percentages of their total obligation. The number of projects at each IC that supports nutrition research is also included.

TABLE 1. Actual Obligations for NIH Nutrition Research and Training in Current and Constant Dollars and as a Percentage of Total NIH Obligations, FY19–FY23 (in thousands of dollars)

Fiscal Year	Nutrition Research & Training Current Dollars[a]	Nutrition Research & Training Constant Dollars[b]	Actual Total NIH Obligations[c]	Constant Nutrition Dollars as a Percentage of Actual Total NIH Obligations
2019	$1,931,268	$1,931,268	$39,420,151	4.90
2020	$2,047,194	$2,012,392	$41,524,839	4.85
2021	$2,065,040	$1,980,373	$42,738,079	4.63
2022	$2,102,819	$1,928,285	$45,327,368	4.25
2023	$2,230,647	$1,967,431	$48,371,641	4.07

[a] Source: NIH RePORT using the Nutrition RCDC category.

[b] Based on the Biomedical Research and Development Price Index, Fiscal Year 2019 equals 100 percent.

[c] Source: NIH Budget Office Actual Total Obligations by Institute and Center FY00–FY23. The amounts for FY22 and FY23 include ARPA-H.

TABLE 2. Funding for Nutrition Research and Training in Current Dollars by NIH Component , FY21–FY23 [a]

Institute/Center[b]	FY2021	FY2022	FY2023
FIC	$2,406,345	$1,955,356	$2,533,927
NCATS[c]	$4,088,748	$2,204,068	$2,584,975
NCCIH	$21,449,270	$21,449,230	$21,508,669
NCI	$154,938,472	$166,451,148	$191,138,835
NEI	$18,672,702	$20,343,976	$19,600,759
NHGRI	$10,408,983	$12,102,291	$19,338,861
NHLBI	$251,887,494	$248,893,450	$265,585,764
NIA	$192,905,133	$194,070,164	$193,797,055
NIAAA	$24,810,596	$27,393,862	$30,221,841
NIAID	$105,298,717	$114,553,918	$119,102,124
NIAMS	$18,057,228	$19,378,505	$17,882,129
NIBIB[c]	$2,640,356	$2,817,396	$5,656,879
NICHD	$115,079,645	$123,448,445	$127,808,951
NIDA	$14,517,299	$19,413,999	$16,200,911
NIDCD	$23,983,492	$22,787,918	$20,333,989
NIDCR	$13,816,475	$12,680,632	$6,775,216
NIDDK	$703,872,514	$679,936,032	$726,761,081
NIEHS	$77,417,359	$61,840,905	$74,016,451
NIGMS	$77,721,456	$83,070,379	$78,921,457
NIMH	$31,775,902	$35,450,233	$41,137,274
NIMHD	$44,085,247	$56,687,402	$56,215,995
NINDS	$31,498,709	$33,273,873	$29,688,824
NINR	$20,174,680	$19,842,735	$22,637,453
NLM[c]	$1,400,420	$1,135,111	$1,327,115
OD[d]	$102,132,784	$121,638,040	$139,870,539
Total	**$2,065,040,026**	**$2,102,819,068**	**$2,230,647,074**

[a] All amounts are from Research, Condition, and Disease Categorization categorical spending data. Total funding for NIDDK includes the Special Type 1 Diabetes Program.

[b] See Appendix B for definitions of institute/center acronyms.

[c] The National Center for Advancing Translational Sciences (NCATS), National Institute of Biomedical Imaging and Bioengineering (NIBIB), and National Library of Medicine (NLM) did not provide written summaries about their respective nutrition research directions for this report.

[d] The NIH Office of the Director (OD) includes the Office of Behavioral and Social Sciences Research, Office of Data Science Strategy, Office of Dietary Supplements, Office of Disease Prevention, Office of Research Infrastructure Programs, Office of Research on Women's Health, and Office of Strategic Coordination—Common Fund for the purposes of this table.

TABLE 3. NIH Nutrition Research Funding in Current Dollars as a Percentage of Total IC Obligations and Number of Projects by NIH Component, FY23

Institute/Center[a]	Number Projects[b]	Nutrition Research & Training[b]	Total IC Obligations[c]	Nutrition as Percentage of Total IC Obligations
FIC	23	$2,533,927	$95,115,000	2.66
NCATS	13	$2,584,975	$923,301,000	0.28
NCCIH	80	$21,508,669	$170,272,000	12.63
NCI	416	$191,138,835	$7,226,503,000	2.64
NEI	38	$19,600,759	$896,081,000	2.19
NHGRI	15	$19,338,861	$660,472,000	2.93
NHLBI	559	$265,585,764	$3,984,921,000	6.66
NIA	380	$193,797,055	$4,412,066,000	4.39
NIAAA	74	$30,221,841	$596,605,000	5.07
NIAID	233	$119,102,124	$6,562,687,000	1.81
NIAMS	52	$17,882,129	$687,579,000	2.60
NIBIB	16	$5,656,879	$440,590,000	1.28
NICHD	323	$127,808,951	$1,747,719,000	7.31
NIDA	33	$16,200,911	$1,663,319,000	0.97
NIDCD	67	$20,333,989	$534,327,000	3.81
NIDCR	29	$6,775,216	$520,092,000	1.30
NIDDK	1,675	$726,761,081	$2,431,540,000	29.89
NIEHS	173	$74,016,451	$996,599,000	7.43
NIGMS	261	$78,921,457	$3,239,664,000	2.44
NIMH	101	$41,137,274	$2,269,370,000	1.81
NIMHD	124	$56,215,995	$525,076,000	10.71
NINDS	88	$29,688,824	$2,772,943,000	1.07
NINR	45	$22,637,453	$197,626,000	11.45
NLM	4	$1,327,115	$494,982,000	0.27
OD[d]	232	$139,870,539	$2,777,639,000	6.85
Total	**5,054**	**$2,230,647,074**	**$46,827,088,000**	**4.76**

[a] See Appendix B for definitions of acronyms.

[b] Source: NIH RePORT. Total funding for NIDDK includes the Special Type 1 Diabetes Program.

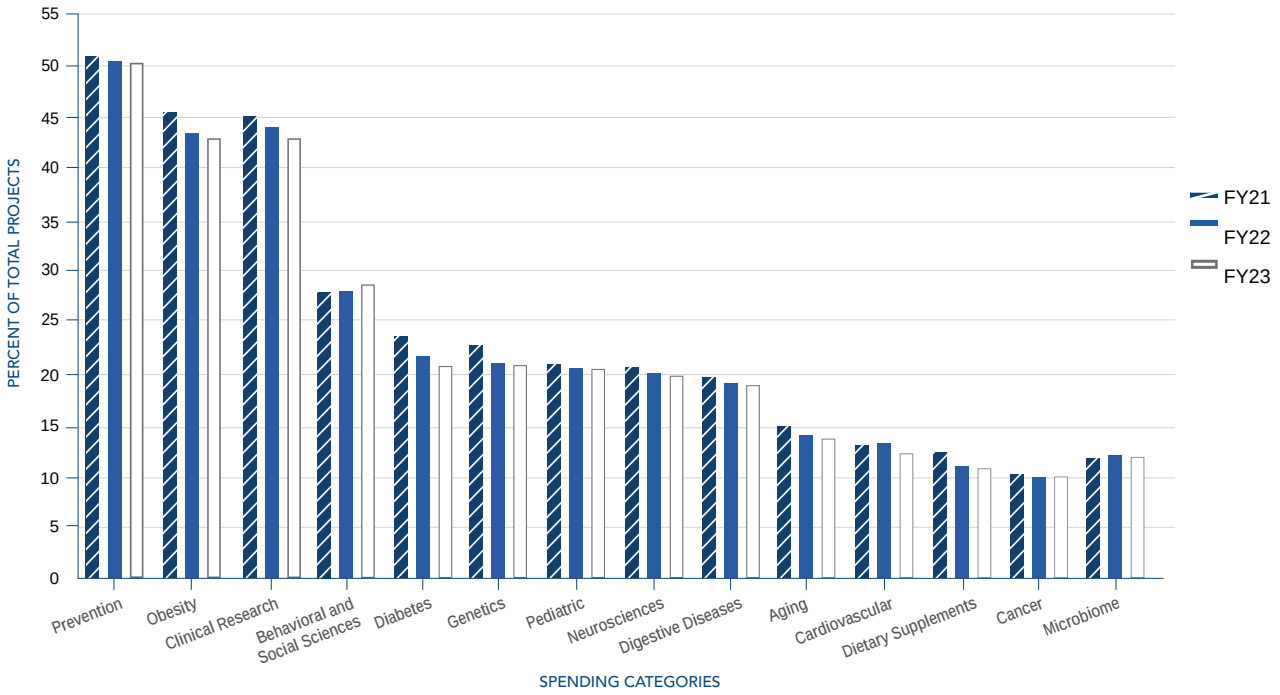
[c] Source: NIH Budget Office Actual Total Obligations by Institute and Center FY00-FY23.

[d] The NIH Office of the Director (OD) includes the Office of Behavioral and Social Sciences Research, Office of Data Science Strategy, Office of Dietary Supplements, Office of Disease Prevention, Office of Research Infrastructure Programs, Office of Research on Women's Health, and Office of Strategic Coordination—Common Fund for the purposes of this table.

SPENDING CATEGORIES

NIH research projects may meet the criteria of multiple fingerprints, and most nutrition projects are categorized under other spending categories, in addition to nutrition. Figure 1 shows the spending categories that appear most frequently in projects categorized as nutrition. Just over half of the nutrition projects funded in FY22–FY23 also were categorized as Prevention, and nearly half were categorized as Obesity or Clinical Research.

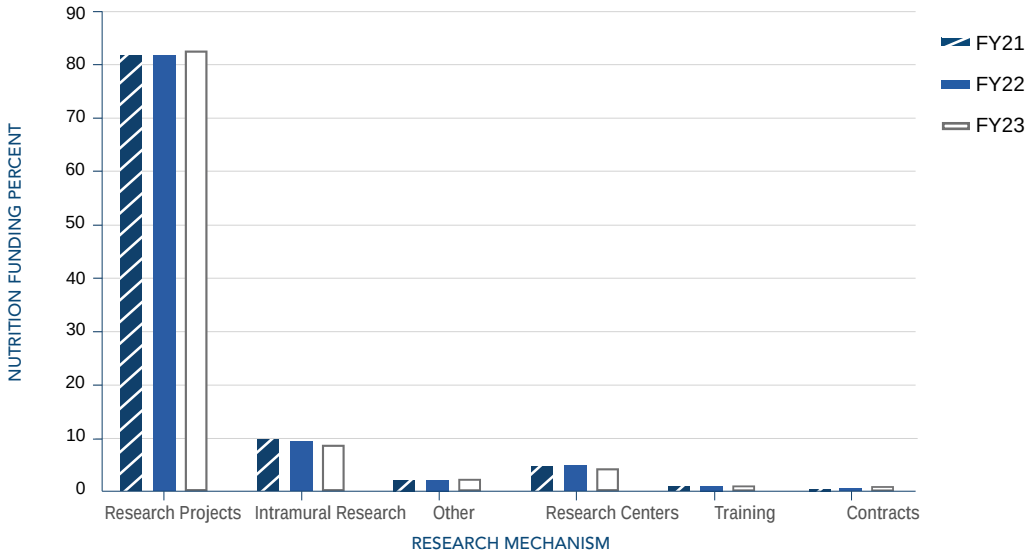
FIGURE 1. Overlapping Spending Categories as a Percentage of Total Projects, FY21–FY23



FUNDING MECHANISM

Figure 2 shows the percentage of FY21–FY23 nutrition funding by research mechanism. Extramural and intramural projects comprised 90 percent of the NIH nutrition research portfolio in FY23. Within the extramural category, research project grants comprised the largest category of support. NIH supports training in biomedical and behavioral nutrition research primarily through two extramural mechanisms: institutional awards and individual awards. The institutional awards, commonly called "training grants," are designed to enable institutions to offer training awards to individuals they select for predoctoral and postdoctoral research training. The predoctoral and postdoctoral individual awards are offered as fellowships or career awards to provide research training to individuals to broaden their scientific background and extend their potential for conducting research.

FIGURE 2. Nutrition Funding Percentages by NIH Research Mechanism, Fiscal Years 2021–2023 (FY21–FY23)



V. NIH Nutrition Research News

NIH-supported nutrition research led to important discoveries in FY22 (October 1, 2021–September 30, 2022) and FY23 (October 1, 2022–September 30, 2023). Many of these discoveries were announced in an NIH News Release or published in *NIH Research Matters*. The list below includes a sample of research highlights; a more comprehensive list of NIH nutrition-related press releases and *NIH Research Matters* articles can be found in Table 4.

HIGHLIGHTS FROM NIH NEWS RELEASES AND NIH RESEARCH MATTERS

Cancer Treatment

Researchers led by Dr. Giorgio Trinchieri of NIH's National Cancer Institute (NCI) and Drs. Carrie Daniel and Jennifer Wargo from The University of Texas MD Anderson Cancer Center examined the links between diet, gut microbes, and response to immunotherapy in 128 people with melanoma.

The participants reported their eating patterns and any use of probiotic supplements in the month before receiving immunotherapy. The team also took stool samples to analyze participants' gut microbiomes. Results were published on December 24, 2021, in *Science*. People who reported higher fiber intake, which promotes healthy gut microbes, had better responses to treatment overall. After adjusting for other factors, the researchers found that every 5-gram increase in daily fiber intake corresponded to a 30 percent lower risk of cancer progression or death. Read more.

Diet and Microbes

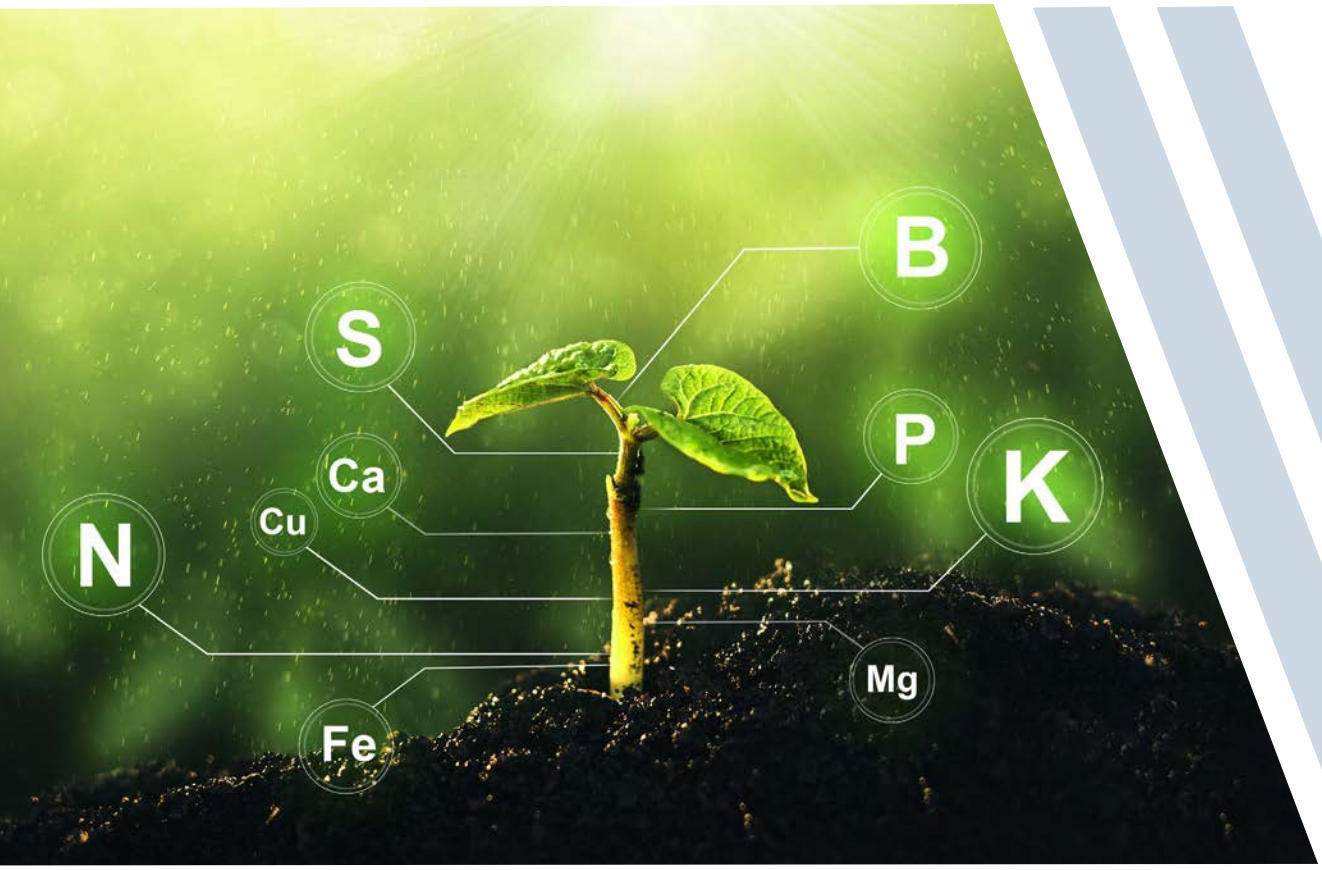
Western-style diets, which are high in fat and sugar, are linked to weight gain. In turn, excess weight and obesity can lead to metabolic diseases, such as type 2 diabetes. The mechanisms in the body that underlie these relationships are not fully understood. They are thought to involve the immune system and the microbes that live in the gut. NIH-funded researchers led by Dr. Ivaylo Ivanov from Columbia University have been using mice to look at these complex relationships. In their new study, they carefully compared mice fed a diet high in fat and sugar with mice fed a low-sugar diet. Results were published on September 15, 2022, in *Cell*. Read more.

Dietary Fiber and Metabolic Health

Dietary fiber reduces the risk of metabolic disorders, such as obesity. Chitin is a common type of fiber found in fungi and the exoskeletons of insects and crustaceans. It can trigger an immune response akin to an allergic reaction. Unlike most dietary fibers, chitin can be digested by mammals, but the mechanism by which this happens is unclear. An NIH-funded research team led by Dr. Steven Van Dyken at Washington University in St. Louis examined how the immune and digestive systems of mice respond to eating chitin. Their findings appeared in *Science* on September 8, 2023. Read more.

TABLE 4. Selected Nutrition-Related NIH News in 2022–2023 in Reverse Chronological Order

Date	Title
9/26/2023	Immune response to eating chitin linked to better health
6/13/2023	Daily multivitamin may enhance memory in older adults
2/7/2023	Probiotic blocks staph bacteria from colonizing people
1/10/2023	Gut microbes may affect motivation to exercise
11/22/2022	COVID-19 disrupts gut microbiome
11/1/2022	How timing of eating affects metabolism and weight gain
10/4/2022	How diet may disrupt gut microbes to promote weight gain
9/20/2022	Black tea drinking associated with reduced deaths
6/14/2022	Improved dietary supplement for age-related macular degeneration
5/24/2022	Health benefits of dietary fibers vary
3/8/2022	Getting sufficient sleep reduces calorie intake
3/1/2022	Calorie restriction, immune function, and health span
2/8/2022	Oral immunotherapy for peanut allergy in young children
2/1/2022	Gut cells distinguish between sugar and artificial sweeteners
1/25/2022	Fiber in diet linked to cancer immunotherapy response
12/23/2021	A high-fiber diet may improve the response of melanoma patients to immunotherapy
12/14/2021	Daytime meals may reduce health risks of night shift work
12/7/2021	Why you feel full after eating



VI. NIH-Sponsored Nutrition Conferences, Seminars, VideoCasts, Webinars, Workshops, and Other Educational Opportunities

NIH-supported events play a key role in the advancement of nutrition science. These forums provide an opportunity to share information and identify research gaps and scientific priorities, as well as stimulate new areas for research. Table 5 lists relevant nutrition-related events that were sponsored or co-sponsored by NIH ICOs in FY22 and FY23, which covers the time period of October 1, 2021, through September 30, 2023. Each of the events in this table are accompanied by a link to access more information about the meeting (if available), which may include the agenda, video recording, or publications that resulted from the discussions that took place at the event.

TABLE 5. NIH-Sponsored Nutrition Conferences, Seminars, VideoCasts, Webinars, Workshops, and Other Educational Opportunities, FY22–FY23

Title	Event Type	Date(s)	Additional Information
Diet as Microbiome Centered Therapy for Chronic Inflammatory Disease	Webinar	10/19/2021	NIH Events Calendar
ODS 25th Anniversary Scientific Symposium	Scientific Symposium	10/25–26/2021	Day 1 VideoCast Day 2 VideoCast
Lessons Learned from Global Food and Nutrition Insecurity	Webinar	11/3/2021–2022	FIC Webinar Webpage
A Guide to Designing Studies of Diet Microbiome Interactions	Scientific Symposium	11/17/2021	NIH Events Calendar
NIH Director's Seminar Series: A Neural Basis Behind the Hardships of Dieting	Scientific Symposium	1/14/2022	NIH VideoCast Recording*
Dietary Risk Factors of Type 1 Diabetes	Seminar Series	2/10/2022	NIH Events Calendar*
Exercise and Physical Activity Intervention in Pediatric Cancer Survivors: From Clinical Applications to Policy	Webinar	3/28/2022	ODP Webinar Webpage

*This event recording is available only to Department of Health and Human Services employees.

Title	Event Type	Date(s)	Additional Information
Discovering a Protein Channel That Is Required for Sour Taste: From Function to Structure	Seminar Series	5/9/2022	NIH Events Calendar
Mary Frances Picciano Dietary Supplement Research Practicum	Educational Opportunity	5/23–25/2022	ODS Event Webpage
2022 NIH & FDA Glycoscience Research Day	Scientific Symposium	6/13/2022	Symposium Agenda
Advancing Research on Emotional Well-Being and Regulation of Eating	Webinar	6/23/2022	NCCIH Webinar Webpage
Pathways to Prevention (P2P) Program: Nutrition as Prevention for Improved Cancer Health Outcomes	Scientific Workshop	7/26–28/2022	ODP Workshop Webpage
Oral Microbiome: An Essential Interface Between Diet and Human Health	Scientific Workshop	7/27/2022	NIH Events Calendar
Dietary Compensation, Time-Restricted Feeding and Associated Metabolic Reprogramming in Healthspan and Longevity Regulation	Scientific Workshop	8/22/2022–8/23/2022	NIA Workshop Webpage
Introduction to Sensory Science and Eating Behavior Research Conducted at the Division of Human Nutrition and Health, Wageningen University	Scientific Workshop	9/6/2022	NIH Events Calendar
Obesity Research Task Force Symposium: The Global Impact of Obesity	Webinar	9/9/2022	NIDDK Webinar Webpage
Malnutrition in Clinical Settings: Research Gaps and Opportunities Workshop	Scientific Workshop	9/12/2022–9/14/2022	ONR Workshop Webpage
Weight Stigma, Internalization, and Health: Opportunities for Intervention	Seminar Series	9/16/2022	NIH VideoCast Recording*
Obesity, Compulsive Eating, and Stress: Insights from the Lab, Field, and Clinical Trials	Seminar Series	9/16/2022	NIH Events Calendar

*This event recording is available only to Department of Health and Human Services employees.

Title	Event Type	Date(s)	Additional Information
Childhood Obesity & Metabolic Risk in Minority Populations	Seminar Series	9/20/2022	NIH Events Calendar
Defining the Public Health Threat of Dietary Supplement Fraud	Seminar Series	9/21/2022	ODS Seminar Series Webpage
2022 Annual Mid Atlantic Diabetes Obesity Research Symposium	Webinar	9/23/2022	NIDDK Webinar Webpage
Oral Microbiome: An Essential Interface Between Diet and Human Health	Educational Opportunity	9/27/2022	NIH Events Calendar
Healthful Lunches for Growing Kids	NIH Employee-only Event	10/12/2022	NIH Events Calendar
Socio-Ecological Factors and the Double Burden of Malnutrition (DBM) Among Children and Adolescents in Low- and Middle-Income Countries (LMICs)	Webinar	10/19/2022–10/20/2022	NICHD Webinar Webpage
Eurest Teaching Kitchen: Budget Conscious Meal Planning in an Inflationary World Cooking Demo	NIH Employee-only Event	10/20/2022	NIH VideoCast Recording
The Gut Microbiome and Dietary Acculturation among U.S. Immigrants	Webinar	10/20/2022	Webinar Webpage
Protective Interorgan, Intercellular, and Intercompartmental Metabolite Shuttles in Obesity	Webinar	10/28/2022	NIH Events Calendar
Patient Nutrition and the Electronic Health Record	Seminar Series	11/2/2022	ODS Seminar Series Webpage
The Global Food and Nutrition Insecurity Webinar Series: Overview of Glogad Food and Nutrition Insecurity	Webinar	11/3/2022	NIH VideoCast Recording
Workshop on Housing and Obesity: Gaps, Opportunities, and Future Directions for Advancing Health Equity	Scientific Workshop	11/14/2022–11/15/2022	NIDDK Workshop Webpage
Global Food and Nutrition Insecurity Webinar Series: Using Implementation Science to Address Food and Nutrition Insecurity	Webinar	11/21/2022	NIH VideoCast Recording

Title	Event Type	Date(s)	Additional Information
Impact of Social and Socioeconomic Disadvantage on Children's Diet and Eating Behavior	Seminar Series	12/8/2022	NIH Events Calendar
Facts About Fat Tissue in Obesity, Health, and Disease	Seminar Series	12/13/2022	NIH Events Calendar
The Use of Comparative Nutrigenomics to Select Human-relevant Animal Models	ODS Seminar Series	12/14/2022	ODS Seminar Series Webpage
Small Quantity Lipid Based Nutrient Supplements for the Prevention of Child Malnutrition	ODS Seminar Series	1/11/2023	ODS Seminar Series Webpage
Application of Metabolomics in Pediatric Type 2 Diabetes	Webinar	1/18/2023	NIH Events Calendar
Cost Effective Interventions That Can Prevent Obesity and Chronic Disease, and Improve Health Equity	Webinar	1/19/2023	ODP Webinar Webpage
Community-engaged Approaches for Preventing and Controlling Obesity Among U.S. Latinos/Hispanics	NIH Videocast	2/8/2023	NIH VideoCast Recording
Diet and the Microbiome: an Ecological and Evolutionary Perspective	Webinar	2/8/2023	ODS Seminar Series Webpage
Food Politics 2023: Supplements, Diets, Food Systems	Seminar Series	3/1/2023	ODS Seminar Series Webpage
Unraveling Diabetes Disparities and Metformin Action in Youth Onset Type 2 Diabetes	Seminar Series	3/2/2023	NIH Events Calendar
Eurest Teaching Kitchen	NIH Videocast	3/28/2023	NIH VideoCast Recording
ADVANTAGE (Agriculture and Diet: Value Added for Nutrition, Translation, and Adaptation in a Global Ecology) Working Group seminar	Seminar Series	4/14/2023	NIH VideoCast Recording
Fat: Biology and Staying Thin	Seminar Series	4/18/2023	NIH VideoCast Recording
Anemia: Report Developed by the USAID Advancing Nutrition Anemia Task Force	ODS Seminar Series	4/19/2023	ODS Seminar Series Webpage

Title	Event Type	Date(s)	Additional Information
ADVANTAGE (Agriculture and Diet: Value Added for Nutrition, Translation, and Adaptation in a Global Ecology) Working Group seminar	Webinar	4/20/2023	NIH VideoCast Recording
NHLBI Obesity, Nutrition and Physical Activity Seminar: Intermittent Fasting and the Circadian Clock: Does When You Eat Affect Your Health?	Webinar	4/20/2023	NHLBI Webinar Webpage
ADVANTAGE (Agriculture and Diet: Value Added for Nutrition, Translation, and Adaptation in a Global Ecology) Working Group seminar	Webinar	4/27/2023	NIH VideoCast Recording
Time-Restricted Eating Research: 2020 PQ2 Grantee Perspectives on Lessons Learned, Gaps, and Opportunities	Webinar	5/19/2023	ODP Webinar Webpage
Use of C. Elegans as a Model for Hyperglycemia	Seminar Series	5/16/2023	NIH Events Calendar
2023 Demystifying Medicine Lecture Series: Diabetes Mellitus: Progress and Challenges	Seminar Series	5/16/2023	NIH VideoCast Recording
Moving Toward Equity in Obesity Treatment Outcomes in Black Women: Exploring the Role of Binge and Emotional Eating	Seminar Series	5/19/2023	NIH Events Calendar
Mary Frances Picciano Dietary Supplement Research Practicum	Educational Opportunity	5/22/2023–5/24/2023	ODS Event Webpage
Advances in Childhood Obesity Research by the Environmental influences on Child Health Outcomes (ECHO) Program	Seminar Series	6/6/2023	Seminar Series Webpage
ADVANTAGE (Agriculture and Diet: Value Added for Nutrition, Translation, and Adaptation in a Global Ecology) Working Group seminar	Webinar	6/12/2023	NIH VideoCast Recording
The Challenge and Promise of Food Is Medicine	Webinar	6/29/2023	ODP Webinar Webpage
NIH Workshop on Multigenerational Nutrition Influences on Health and Disease	Scientific Workshop	7/12/2023–7/13/2023	NIH VideoCast Day 1 NIH VideoCast Day 2
Interactions Between Diet, the Gut Microbiome, and Epigenetics that Influence Health and Disease	Webinar	7/27/2023	Virtual Seminar

Title	Event Type	Date(s)	Additional Information
Advancing Health Equity Via Community Based Participatory Policy Research on Neighborhood Food and Built Environments	Seminar Series	8/10/2023	NIH Events Calendar
New Directions in Community Based Interventions to Improve Food Access and Reduce Obesity in Baltimore	Webinar	8/29/2023	NIH VideoCast Recording
A Time to Eat, a Time to Exercise: Chronobiology to Improve Metabolic Health	Seminar Series	9/7/2023	NIH Events Calendar
Otimizing Dietary Amino Acid Intake to Improve Human Health and Reduce the Burden of Age Related Disease	Scientific Workshop	9/7/2023–9/8/2023	Workshop Webpage
NIH Obesity Research Task Force Symposium: Medications to Treat Obesity: Past, Present, and Future	Webinar	9/8/2023	NIDDK Workshop Webpage
Updates from the FDA Office of Dietary Supplement Program	Seminar Series	9/13/2023	ODS Seminar Series Webpage
2023 Annual Mid-Atlantic Diabetes and Obesity Research Symposium	Scientific Workshop	9/22/2023	NIDDK Symposium Webpage
Advancing Health Equity Through Culture–Centered Dietary Interventions to Address Chronic Diseases	Scientific Workshop	9/28/2023–9/29/2023	NHLBI Event Webpage
Microphysiological Systems (MPS) for Studying T2D, Obesity, and Their Complications	Webinar	9/28/2023–9/29/2023	NIDDK Workshop Webpage

VII. Nutrition Practicums

Several ICs offer practicums with the goal of expanding specific research interests. Both NCI and the NIH ODS offer annual nutrition-related research practicums. These practicums are open to the public at no charge but require an application.

JOHN MILNER NUTRITION AND CANCER PREVENTION RESEARCH PRACTICUM

NIH and the U.S. Department of Agriculture (USDA) offer a 1-week educational opportunity in nutrition and cancer prevention research—the John Milner Nutrition and Cancer Prevention Research Practicum—for individuals with a sustained commitment to nutrition and health promotion.

Offered since 2004, this intensive learning session provides specialized instruction on the role of diet and bioactive food components as modifiers of cancer incidence and tumor behavior and engages participants through didactic and interactive experiences. The practicum is not intended to enhance patient education or clinical practice; rather, it is best suited for those interested in expanding their research efforts.

The practicum is open—at no cost—to graduate students; registered dietitian nutritionists; students enrolled in an Accreditation Council for Education in Nutrition and Dietetics–accredited supervised-practice program or combined with graduate studies; nongovernment academicians; physicians; and other health care professionals in the early stages of their careers. Preference is given to individuals with relevant experience in nutrition and cancer research. International applicants are welcome. Those who have previously participated in the practicum are not eligible. A full-week commitment from the participant is required.

MARY FRANCES PICCIANO DIETARY SUPPLEMENT RESEARCH PRACTICUM

The Mary Frances Picciano Dietary Supplement Research Practicum is an annual 2½-day educational opportunity offered by ODS that provides fundamental knowledge of dietary supplements. This intensive practicum provides a thorough overview and foundation of issues, concepts, unknowns, and controversies about dietary supplements and supplement ingredients. It also emphasizes the importance of scientific investigations to evaluate the efficacy, safety, and value of these products for health promotion and disease prevention, as well as how to conduct this type of research.

This practicum is open—at no cost—to select faculty, graduate students, and research practitioners in such health-related disciplines as nutrition, food science, pharmacy, pharmacology and pharmacognosy, exercise science and kinesiology, medicine, dentistry, nursing, and complementary and alternative medicine. Preference will be given to candidates who are full-time academic faculty, research practitioners, doctoral students, postdoctoral students, and fellows. Applications also will be accepted from master's-level students, students in allied health schools, and health care providers and scientists with a master's degree or higher whose work involves research with dietary supplements. The practicum is limited to approximately 100 attendees per session. Previous practicum presentation videos are available online.

VIII. Nutrition-Related NIH-Wide Committees and Working Groups

Several groups are engaged in collaborative nutrition-related activities at NIH. These activities facilitate the sharing of resources and expertise, and they foster communication and opportunities for collaboration within the NIH nutrition science community. Key groups with representation from across NIH are listed and described below.

OFFICE OF NUTRITION RESEARCH THEMATIC WORKING GROUPS

The Office of Nutrition Research (ONR) is establishing thematic working groups to achieve its goal of providing service and technical support to NIH institutes, centers, and offices (ICOs) and relevant agencies across the U.S. government. Each thematic working group is charged to take an ecological approach to their specific area of science—appreciating that nutrition is part of a holistic ecosystem and that humans are complex biological systems affected by both internal (e.g., biology, genetics, microbiome, health context, developmental stage) and external (e.g., household, community, school, physical, environmental) factors.

Analytical Approaches to Address Complexity to Support Clinical Care and Public Health

This working group will focus on the identification and development of analytical approaches to address the complexities engendered by taking an ecological approach to nutrition-related research. This includes targeting the application of analytical approaches to clinical assessment, population surveillance, and best practices to ensure rigor and reproducibility of nutrition-related research with the goal of translation and implementation to support evidence-informed, equitable, and safe interventions, standards of care, and public health interventions.

Diversity in the Nutrition Workforce

This working group will focus on identifying opportunities to enhance diversity in the nutrition workforce across the educational and career spectrum. This effort will span training, mentoring, career development, novel research opportunities, and networking possibilities, among other innovative ideas.

Food Is Medicine

This working group will focus on conceptualizing small- and large-scale activities that would be synergistic with other federal and nonfederal Food is Medicine efforts. Of particular interest to this working group is the impact of Food is Medicine efforts on health outcomes.

Microbiomes, Diet, and Health

This working group will focus on advancing research to better understand the diet-microbiome-host interrelationships. Topics of relevance to this working group include the interrelationships among diet, nutrients, and microbiomes (especially the gut and oral microbiomes) throughout the lifespan and health outcomes.

NIH and U.S. Government Nutrition-related Research Infrastructure

This working group will focus on the infrastructure and resources necessary to optimize nutrition research at a national level. This includes both existing and new NIH and U.S. government infrastructure and resources.

Nutrition and Health Disparities

This working group will focus on advancing research to better understand the interactions among diet, nutritional status, the environment, and biological and behavioral processes and how they contribute to health disparities. This working group will also address research on how to prevent and treat nutrition-related diseases and reduce health inequities.

Nutrition and Health in Later Life

This working group will focus on advancing research addressing the role of nutrition in healthy aging. Topics of relevance to this working group include nutrition in the health of older adults, as well as nutrition and menopause.

Nutrition and Health in Pregnancy and Early Life

This working group will focus on advancing research to optimize nutrition and health during pregnancy, lactation, early life, and adolescence. Topics of relevance to this working group include human milk and infant feeding, as well as nutrition and reproductive health.

The Intersection of Food Systems, Diet, Nutrition, and Health in a Changing Environment

This working group will focus on advancing research addressing the reciprocal relationships between climate and environmental changes and nutrition. Topics of relevance to this working group include sustainability and dietary patterns as well as the relationships between food systems, planetary health, and human health.

STRATEGIC PLAN FOR NIH NUTRITION RESEARCH: COMMITTEE AND WORKING GROUP SUPPORT

The NIH Nutrition Research Report received additional input and support from the following committees and working groups.

Nutrition Research Coordinating Committee

The NIH Nutrition Research Coordinating Committee (NRCC) was established in 1975 for the primary purpose of reviewing, discussing, and stimulating support for nutrition research and training within NIH. Today, the NRCC is a vibrant group whose membership includes representatives and interested staff from NIH ICOs and other federal agencies. The NRCC is chaired by the ONR Director. NRCC meetings occur monthly and typically include scientific seminars, nutrition research program and policy updates, information about research interests, and collaborative project activities.

Nutrition Education Subcommittee

The NIH Nutrition Education Subcommittee (NES), a subcommittee of the NRCC, is led by ONR and reviews federal nutrition education materials that contain dietary guidance for the general population. A congressional mandate for reviews of these materials was enacted in 1990 to ensure that nutrition education materials produced by federal agencies are consistent with the Dietary Guidelines for Americans (DGA) and that all agencies within the Departments of Health and Human Services (HHS) and Agriculture (USDA) provide consistent nutrition information and advice. The NES reviews nutrition education materials in several formats, including printed and electronic media such as brochures and fact sheets, web pages, videos, and audio format messages that are intended for the general public.

Obesity Research Task Force

The NIH Obesity Research Task Force (ORTF) was formed to provide the research community a platform to exchange information on a broad spectrum of NIH-sponsored obesity-related research, including molecular, genetic, behavioral, environmental, clinical, and epidemiologic studies. The ORTF is co-chaired by the Directors of the NIDDK; the National Heart, Lung, and Blood Institute (NHLBI); and the NICHD. Members of the ORTF include representatives from these and many other NIH institutes and centers (ICs).

Coordinating Committee on Research on Women's Health

NIH IC Directors or their designees comprise the NIH Coordinating Committee on Research on Women's Health (CCRWH). As established by legislative mandate in the NIH Revitalization Act of 1993, CCRWH members serve as direct liaisons between the NIH Office of Research on Women's Health (ORWH) and NIH ICs. The CCRWH provides valuable guidance, collaboration, and support to ORWH program goals, including ORWH's career development programs and outreach efforts.

Specific CCRWH support involves—

- Serving as a resource for women's health activities across the NIH
- Supporting methods to gather data by age and ethnic/racial groups of women's participation in clinical trials
- Supporting the development and expansion of clinical trials necessary to the health of women
- Encouraging and supporting research on women's health
- Identifying needs regarding the coordination of research activities, including intramural and extramural multidisciplinary activities

HIV/AIDS Executive Committee

The NIH HIV/AIDS Executive Committee (NAEC) is the coordinating committee for all NIH HIV/AIDS research and provides recommendations to the Director of the Office of AIDS Research (OAR) regarding the development and implementation of HIV/AIDS research programs and funding priorities in accordance with the NIH Strategic Plan for HIV and HIV-Related Research. The NAEC also facilitates inter and intra-agency communication among the OAR and ICOs to coordinate program initiatives and assists in the development of NIH-wide HIV/AIDS research plans, policies, and procedures. NAEC membership primarily includes a designated HIV/AIDS Coordinator from each ICO with an HIV/AIDS research budget.

Prevention Research Coordinating Committee

The Prevention Research Coordinating Committee (PRCC) is an NIH-wide committee that provides a forum for NIH ICs and other federal partners to exchange programmatic and scientific information on prevention research activities that are sponsored by federal agencies and other organizations. The NIH Office of Disease Prevention (ODP) coordinates the Committee's activities. The PRCC advises the ODP Director and provides recommendations regarding scientific, programmatic, and policy issues related to health promotion and disease prevention.

NIH-wide Microbiome Working Group

The NIH-wide Microbiome Working Group was established in 2012 to provide a forum for coordinating NIH extramural research activities related to the human microbiome. Working Group membership is open to all extramural program staff from ICs with an interest in the human microbiome. Working Group meetings occur monthly.

IX. Key Collaborations

Interagency collaboration enhances the field of nutrition. Ongoing collaborative efforts are highlighted below.

DIETARY GUIDELINES FOR AMERICANS

The *Dietary Guidelines for Americans* (DGA) are the foundation of federal food and nutrition programs, policies, and education initiatives. The DGA are issued jointly by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (HHS) every 5 years, as required by law. The *Dietary Guidelines* are informed by a scientific report prepared by a federal advisory committee and comments received from federal agencies, industry, organizations, and consumers. The most current version is the *2020–2025 Dietary Guidelines for Americans*.

USDA and HHS identified topics and scientific questions to be examined by the 2020 Dietary Guidelines Advisory Committee prior to establishing the Committee. The Departments added this step to promote a deliberate and transparent process, respond to feedback on the *Dietary Guidelines* development process, identify expertise needed on the Committee, help manage resources, and ensure that the scientific review conducted by the Committee addresses federal nutrition policy and program needs.

USDA and HHS requested public nominations to the 2020 Dietary Guidelines Advisory Committee from September 6 to October 6, 2018. In February 2019, 20 nationally recognized scientists were appointed to serve on the Committee. The Committee's work ended with the release of its scientific report to the Secretaries of USDA and HHS. The two agencies then worked together to develop the *2020–2025 Dietary Guidelines*.

DIETARY REFERENCE INTAKES

Dietary Reference Intakes (DRIs) are nutrient reference values developed by the National Academies of Sciences, Engineering, and Medicine. The DRIs are intended to serve as a guide for nutritional intake and provide the scientific basis for the development of food guidelines in the United States and Canada. These nutrient reference values are specified based on age, gender, and life stage and cover more than 40 nutrient substances.

Government coordination of DRI-related activities is a joint effort between representatives of the U.S. and Canadian governments. The U.S.–Canada Joint DRI Working Group and the Interagency Committee on Human Nutrition Research (ICHNR) Subcommittee on Dietary Reference Intakes work together to ensure that the DRI values continue to be scientifically sound, current, and useful for public health purposes. This includes identifying DRI needs and prioritizing nutrient reviews, advancing work to resolve methodology issues, and coordinating funding for new DRI reviews.

DIETARY SUPPLEMENT INGREDIENT DATABASE

The Dietary Supplements Ingredient Database (DSID) contains analytical data on dietary supplement product ingredients. The DSID was developed by the USDA Methods and Application of Food Composition Laboratory in collaboration with the NIH Office of Dietary Supplements (ODS) and other federal agencies. The goals of the DSID project are to establish reliable, analytically predicted estimates of ingredient content in dietary supplement products; compare analyzed levels of ingredients to labeled values provided by manufacturers, if available; and improve dietary intake assessments by providing data files and online calculators that adjust label values into analytically predicted amounts.

DIETARY SUPPLEMENT LABEL DATABASE

The Dietary Supplement Label Database (DSLD) is a joint effort between the National Library of Medicine and ODS, with input from many federal partners. The database contains the full label contents from a sample of dietary supplement products marketed in the United States with a web-based user interface that provides access to label information.

EARLY INTERVENTION TO PROMOTE CARDIOVASCULAR HEALTH OF MOTHERS AND CHILDREN PROGRAM

The Early Intervention to Promote Cardiovascular Health of Mothers and Children (ENRICH) program aims to test the effectiveness of an implementation-ready intervention designed to promote cardiovascular health and address cardiovascular health disparities in both mothers and children (0–5 years old) who are of low socioeconomic status, live in low-resource rural or urban communities, or are in diverse geographic regions of the United States with a high burden of cardiovascular disease risk factors. ENRICH was developed in partnership with several ICOs—including NIDDK, NIMHD, ODP, OBSSR, and ORWH—and other federal agencies,

such as the Health Resources and Service Administration (HRSA) and the Administration for Children and Families (ACF). The 7-year program is in its second year and will run through fiscal year 2028.

FEDERAL DATA CONSORTIUM ON PREGNANCY AND BIRTH TO 24 MONTHS

The Federal Data Consortium (Data Consortium) on Pregnancy and Birth to 24 Months (P/B-24) is a federal forum for sharing information and finding solutions to resolve crucial needs for data on P/B-24 populations to inform public health initiatives. The Data Consortium facilitates the ability of federal agencies to gather and review input to inform projects and research plans and share information on data availability and usage. More than a dozen federal agencies have funded projects coordinated by the Data Consortium that are focused on filling critical gaps in scientific knowledge to support evidence-based programs, policies, and educational initiatives across government and nongovernment sectors. The collaboration spans 185 federal staff and leaders from 30 agencies in five departments: HHS, USDA, the U.S. Agency for International Development (USAID), the U.S. Department of Defense (DoD), and the U.S. Environmental Protection Agency (EPA). The Data Consortium is co-led by representatives from NIH and the Centers for Disease Control and Prevention (CDC), HHS Office of Disease Prevention and Health Promotion (ODPHP), U.S. Food and Drug Administration (FDA), USDA Agricultural Research Service (ARS), and USDA Food and Nutrition Service.

The Data Consortium resulted from efforts by ODPHP within the Office of the Assistant Secretary for Health in 2016 to coordinate "special studies" from CDC's National Health and Nutrition Examination Survey (NHANES) to fill crucial needs for data on P/B-24 populations to support future *Dietary Guidelines for Americans*. These data go beyond the needs of the *Dietary Guidelines*. Initiatives include the Human Milk Composition Initiative and B-24 questionnaire content in the NHANES Diet and Behavior Questionnaire.

FEDERAL WORKING GROUP ON DIETARY SUPPLEMENTS

The Federal Working Group on Dietary Supplements (FWGoDS) is led by ODS and includes representatives from other NIH ICOs and other federal agencies. The FWGoDS provides an opportunity to strengthen collaborative efforts and to share information and discuss issues, initiatives, and research related to dietary supplements. The FWGoDS was established, in part, in response to a congressional mandate that ODS serve as an advisor to federal health agencies on issues related to dietary supplements. The FWGoDS has met twice per year since 2005.

FDA–NIH JOINT AGENCY NUTRITION WORKING GROUP

The FDA–NIH Joint Agency Nutrition Working Group, a subgroup of the FDA-NIH Joint Leadership Council, was formed in 2016 to facilitate high-quality nutrition research to improve public health outcomes across the lifespan in order to reduce risk factors for and incidence of nutrition-related chronic disease and inform nutrition-related regulatory decision-making, consumer outreach, and education.

HEALTHY PEOPLE

Healthy People is a national health promotion and disease prevention agenda that provides a framework for achieving 10-year goals and objectives to improve the nation's health. The Healthy People initiative, which began more than 30 years ago, is grounded in the principle that setting national objectives and monitoring progress toward achieving them can motivate action.

Healthy People objectives are organized within distinct topic areas, for which multiple agencies provide leadership. NIH co-leads many of the topic areas, including Nutrition and Weight Status. For more information about objectives that evaluate access to healthier foods, weight reduction and nutritional counseling in health care and worksite settings, weight status, food insecurity, food and nutrient consumption, and iron deficiency, view the Healthy People 2020 Midcourse Review for Nutrition and Weight Status.

In 2020, a new set of science-based 10-year national objectives—*Healthy People 2030*—was launched, with the goal of improving the health of all Americans by 2030. The development of *Healthy People 2030* included the establishment of a framework for the initiative—including the vision, mission, foundational principles, plan of action, and overarching goals—and identifying new objectives.

INTERAGENCY COMMITTEE ON HUMAN NUTRITION RESEARCH

The Interagency Committee on Human Nutrition Research (ICHNR) aims to increase the overall effectiveness and productivity of federally supported or conducted human nutrition research. Established in 1983 and reassembled in 2013, the ICHNR is

charged with improving the planning, coordination, and communication among federal agencies engaged in nutrition research and facilitating the development and updating of plans for federal research programs to meet current and future domestic and international needs for nutrition. The current co-chairs of the ICHNR are the Assistant Secretary of Health (HHS) and the Under Secretary for Research, Education, and Economics and Chief Scientist (USDA). ONR provides the primary administrative support for the ICHNR, which includes representatives from HHS, DoD, EPA, USAID, USDA, the U.S. Department of Commerce, the Federal Trade Commission, the National Aeronautics and Space Administration, the National Science Foundation, the Veterans Health Administration, and the White House Office of Science and Technology Policy. In addition to its interagency coordination and communication roles, the ICHNR strives to increase the effectiveness and productivity of federal agencies that are engaged in nutrition research by supporting activities to inform researchers and policy staff on ongoing federally supported or conducted human nutrition research, nutrition monitoring, and nutrition program activities.

NATIONAL COLLABORATIVE ON CHILDHOOD OBESITY RESEARCH

The National Collaborative on Childhood Obesity Research (NCCOR) is a public–private partnership undertaken by the CDC, USDA, Robert Wood Johnson Foundation, and NIH. The initiative was launched in 2009, with a primary mission of improving the efficiency, effectiveness, and application of childhood obesity research and halting and reversing the childhood obesity epidemic through enhanced coordination and collaboration. The NCCOR partnership has focused its efforts on identifying, designing, and implementing innovative, practical, and sustainable interventions in diverse settings; increasing national, state, and local obesity surveillance activities; supporting childhood obesity research and program evaluation activities; and identifying ways to optimize research outcomes, build capacity for new research and surveillance, and create and support the mechanisms and infrastructure needed for research translation and dissemination. These efforts have proven enormously successful. NCCOR partners have formed strategic alliances with diverse groups, produced education and training resources for researchers and stakeholders, and informed the broader research community and policymakers of progress in child obesity prevention.

The *2022 NCCOR Annual Report* and *2023 NCCOR Annual Report* are available on the NCCOR website. NCCOR provides a variety of unique tools that may be of interest to researchers. These include a Measures Registry, four Measures Registry User Guides, Measures Registry Learning Modules, a Catalogue of Surveillance Systems, a Registry of Studies, and a Youth Compendium of Physical Activities.

NATIONAL FOOD AND NUTRIENT ANALYSIS PROGRAM

Federal food and dietary supplement product database activities have been coordinated through the National Food and Nutrient Analysis Program (NFNAP) initiative since 1997. NFNAP is directed by the USDA ARS Methods and Application of Food Composition Laboratory (newly formed from a consolidation of the Nutrient Data Laboratory and the Food Composition and Methods Development Laboratory) in collaboration with NCI and ODS, along with other NIH ICOs and the FDA.

The five specific aims of NFNAP are to: (1) institute a monitoring program for key foods and critical nutrients (to date, approximately 1,400 foods have been sampled and analyzed); (2) conduct comprehensive analyses of selected key foods; (3) develop databases for high-priority foods consumed by U.S. ethnic subpopulations; (4) develop and expand databases for selected bioactive components; and (5) develop a validated database for ingredients in dietary supplements. For each specific aim, the process includes identifying foods for analysis; developing unique, statistically based sampling plans; and applying validated analytical chemistry. The primary outcome of the initiative is to develop comprehensive nutrient composition databases that have unprecedented analytical quality.

Several recent accomplishments in food composition analysis and database development can be traced to the NFNAP initiative. A review of the past two decades of collaboration can be found on PubMed.gov. The NFNAP initiative also has supported dietary supplements research and database development—including the DSID, which stemmed from the NFNAP initiative—and the DSLD. Both are described above.

NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY

The National Health and Nutrition Examination Survey (NHANES) is a program of studies designed to assess the health and nutritional status of adults and children in the United States. The survey is unique in that it combines interviews and physical examinations. NHANES is a major program of the National Center for Health Statistics, which is part of the CDC and has the responsibility for producing vital and health statistics for the nation. The NHANES program began in the early 1960s and has been

conducted as a series of surveys focusing on different population groups or health topics. In 1999, the survey became a continuous program with a changing focus on a variety of health and nutrition measurements to meet emerging needs. The survey examines a nationally representative sample of about 5,000 people each year. These people are located in counties across the country, 15 of which are visited each year. The NHANES interview includes demographic, socioeconomic, dietary, and health-related questions. The examination component consists of medical, dental, and physiological measurements, as well as laboratory tests administered by highly trained medical personnel.

PATHWAYS TO PREVENTION (P2P) PROGRAM

ODP's Pathways to Prevention (P2P) Program focuses on Nutrition as Prevention for Improved Cancer Health Outcomes. Using a structured process, the P2P identifies the effect of nutritional interventions on preventing negative cancer treatment outcomes in adults diagnosed with cancer who have or are at risk for cancer-associated malnutrition, as well as the effects of nutritional interventions on symptoms. The program also explores the effects of intentional weight loss before or during cancer treatment and whether nutritional interventions for preventing negative outcomes of cancer treatment are cost-effective.

X. NIH Institute, Center, and Office Research Directions

NIH supports extensive research on the relationship between nutrition and health. Through approaches that focus on both basic and translational research, as well as training investigators, the NIH nutrition portfolio covers a vast array of programs. Details about the specific research directions and priority nutrition areas of each institute, center, and office are in this section.

Clinical Center

https://clinicalcenter.nih.gov

OVERVIEW

The Clinical Center at NIH in Bethesda, Maryland, is part of NIH's intramural science research program and is the nation's largest hospital devoted entirely to clinical research. It is a national resource that makes it possible to rapidly translate scientific observations and laboratory discoveries into new approaches for diagnosing, treating, and preventing disease. Currently, about 1,600 clinical research studies are in progress at the NIH Clinical Center. The clinical trials at the NIH Clinical Center are predominantly Phase 1 and Phase 2, and they often are first-in-human studies to test safety and efficacy. More than 500,000 patients, from all 50 states and throughout the world, have participated in clinical research at the Clinical Center since it opened in 1953.

The Clinical Center promotes translational research—that is, the transfer of scientific laboratory research into applications that benefit patient health and medical care. The "bench-to-bedside" approach adopted in 1953 locates patient care units in close proximity to cutting-edge laboratories conducting related research. This facilitates interaction and collaboration among clinicians and researchers. Most importantly, patients and families in the Clinical Center benefit from the cutting-edge technologies and research and the compassionate care that are signatures of NIH.

The Mark O. Hatfield Clinical Research Center was opened in 2005. It was named in honor of Senator Mark O. Hatfield of Oregon, who supported medical research throughout his congressional career. The facility houses inpatient units, day hospitals, and research laboratories and connects to the original Warren Grant Magnuson Clinical Center. Together, the Magnuson and Hatfield buildings form the NIH Clinical Center. They serve the dual role of providing humane and healing patient care and the environment that clinical researchers need to advance clinical science.

The 870,000-square-foot Hatfield building has 200 inpatient beds and 93 day-hospital stations. This arrangement can be easily adapted to allow more inpatient beds and fewer day-hospital stations, or vice versa, because the facility's design is highly flexible.

KEY ACHIEVEMENTS

Clinical and metabolic research dietitians within the Clinical Center Nutrition Department consult with NIH institute and center investigators to plan, design, and implement nutrition-related components of research protocols. Dietitians recommend optimal methodologies to ensure valid and reliable data and assist with data collection, analysis, and interpretation and manuscript preparation. Dietitians also advise on the benefit and appropriateness of adding nutrition services to existing research protocols.

Clinical Center dietitians also collaborate with professional organizations, academic institutions, consortiums, and nonprofits to provide education on nutrition-related topics specific to diseases under study at the Clinical Center.

The Clinical Center Nutrition Department provides nutrition research services to more than 60 active protocols from 11 NIH institutes and centers with 10 to 20 additional protocols in development at any given time. In fiscal year 2023, 3,263 individual nutrition research services were provided.

Nutrition research services include the following:

Research Meals/Diets

Purpose: To allow for highly controlled food and nutrient intake and presentation, meal timing, and meal appearance to meet protocol needs. Research meals are prepared in a dedicated metabolic research kitchen using specialized equipment and software and include quantification of amount of food consumed. Services include onsite meals, packed out meals, taste preference tests, oral food challenges, and specialized formulas for research purposes.

Dietary Intake and Eating Behavior Assessments

Purpose: To quantify energy, nutrient, and food group intake and diet indices and to characterize eating behaviors. Specialized software and questionnaires are used to analyze dietary intake.

Body Composition Analysis

Purpose: To assess lean and fat mass using circumference and skinfold measurements among other measurements.

Nutrition Counseling

Purpose: To provide standardized nutrition education and counseling to research subjects as part of protocol requirements.

NUTRITION TRAINING

The Clinical Center Nutrition Department housed the NIH Dietetic Internship from 1993 to 2023. This nutrition training program, accredited by the Accreditation Council for Education in Nutrition and Dietetics, provided more than 1,200 hours of supervised practice training necessary for eligibility to sit for the national exam to obtain the Registered Dietitian/Registered Dietitian Nutritionist credential. The internship was the only one in the nation to offer a concentration in clinical nutrition research. The program graduated a total of 31 classes with 119 graduates.

Fogarty International Center

https://www.fic.nih.gov

OVERVIEW

The Fogarty International Center (FIC) is dedicated to advancing the mission of NIH by supporting and facilitating global health research conducted by U.S. and international investigators, building partnerships between health research institutions in the United States and abroad, and training future generations of scientists to address global health needs. FIC currently funds more than 400 research and training projects involving more than 100 U.S. universities and investigators in numerous foreign countries, most of which are in low- and middle-income countries (LMICs). FIC staff engage with scientists around the world to address critical global health research problems, such as emerging infectious diseases, and highlight the need to strengthen research capacity in LMICs.

RESEARCH DIRECTIONS

Through its extramural programs, FIC supports a variety of research efforts that address significant areas of nutrition research. Specifically, FIC has funded research with a large range of nutrition foci across the globe. These efforts have included a program that seeks to evaluate changes in adult dietary patterns and cardiometabolic disease risk profiles associated with the construction of the Interoceanic Highway through Peru's Southern Amazon by measuring biomarkers of the nutritional transition and complementary dietary survey data; and a program that strives to develop and test culturally tailored nutrition therapy to improve dietary adherence of type 2 diabetes patients in Benin, Africa.

NUTRITION TRAINING

FIC is committed to nutrition-related research training projects funded by FIC aim to do the following:

- Provide short-, intermediate-, and long-term training to health professionals who are engaged in population-based and clinical and translational noncommunicable disease research focused on bone health and vitamin D supplementation across the lifespan through the Lebanon-based Scholars in Health Research Program (or SHARP).
- Train doctoral students and postdoctoral fellows at Makerere University in Uganda in the epidemiology and pathogenesis of infection-related neurocognitive impairment, including the assessment of the interactions between micronutrient deficiency and infection, with the goal of establishing a cohort of Ugandan researchers who can advance the understanding, prevention, and treatment of long-term neurocognitive disability associated with infectious diseases and micronutrient deficiency.
- Build sustainable capacity in pediatric infectious disease, gastroenterology, and nutrition research, specifically as they relate to environmental enteric dysfunction and its complications, including vaccine failure, undernutrition, and subsequent growth failure in children residing in Pakistan.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

- In 2022, FIC hosted a three-part webinar series that featured innovative research projects on nutrition and food insecurity and health outcomes in global settings and identified lessons learned and opportunities for adaption in the United States and other contexts. The webinar series supported the work from recent U.S. government investments in food and nutrition security, including the domestically focused White House Conference on Hunger, Nutrition, and Health and the passage of the Global Malnutrition Prevention and Treatment Act of 2021. There was strong NIH and U.S. government engagement throughout the series. The sessions highlighted robust food and nutrition security conceptual frameworks, measurement, and indicators and innovative policy-relevant research examining the intersections of food and nutrition insecurity with other social determinants of health, including water insecurity, as well as how these issues relate to poor physical and mental health outcomes worldwide. The series resulted in a peer-reviewed supplement in *Frontiers in Public Health*.

TOOLS AND RESOURCES

FIC led the recent portfolio analysis on the scope of NIH-funded extramural research grants at the intersection of nutrition research and implementation science from 2011 to 2022 and to offer insights into future research opportunities relevant to the *2020–2030 Strategic Plan for NIH Nutrition Research*.

National Cancer Institute

https://www.cancer.gov

OVERVIEW

Cancer is the second-leading cause of death in the United States. In 2022, there were an estimated 1.9 million new cancer cases diagnosed and 609,360 cancer deaths in the United States. Since the National Cancer Institute (NCI) was established in 1937, scientists have identified various cancer-related factors, such as genetics and environmental exposures. Food and alcohol and their associated constituents are thought to be environmental factors that can significantly influence cancer risk and tumor behavior. The complexity of this area is expanded by the thousands of dietary components that are consumed.

Cancer research and training are performed and supported by both intramural and extramural programs at NCI. NCI makes awards to investigators residing in the United States and at international sites. NCI's goal is to support research that ultimately leads to important clinical outcomes: improvements in prevention, diagnosis, treatment, and survivorship that can reduce the incidence of and morbidity and mortality from all types of cancer. NCI requires a wide range of research disciplines that span the continuum from basic science to clinical research to research on implementation and cancer care delivery. Areas of research that NCI supports include basic sciences (e.g., genetics, genomics, cell biology, immunology, nanotechnology); translational and clinical sciences (e.g., drug development and testing, diagnostics, discovery and development of molecular markers, advanced imaging technologies, new radiotherapy techniques); population sciences (e.g., population genetics, epidemiology, environmental sciences); and behavioral sciences at biological, psychological, sociocultural, environmental, and policy levels. NCI supports various interdisciplinary and transdisciplinary training programs in basic, clinical, and population sciences to foster the development of future national and international scientific leaders who will use modern approaches and technologies to address critical issues in cancer. NCI provides various dietary assessment research resources, such as dietary collection resources (e.g., Dietary Assessment Primer), data collection tools (e.g., Automated Self-Administered 24Hour Dietary Recall, Diet History Questionnaire), food composition databases, and dietary analysis tools (e.g., Healthy Eating Index, World Cancer Research Fund/American Institute for Cancer Research Score).

NCI nutrition research incorporates a variety of approaches for determining the influence of diet, dietary patterns, and dietary components on the cancer process. These approaches include epidemiologic studies (i.e., cross-sectional, case-control, and cohort studies), clinical intervention studies, compositional studies involving food content and components, preclinical studies (e.g., animal models, cell cultures), clinical studies of biochemical/physiologic assessments of nutrient metabolism and absorption patterns, and studies of diet and lifestyle behaviors. In addition, NCI provides summaries of ongoing research related to nutrition and cancer through websites, such as those listed below, and other programs within the Office of Communications and Public Liaison.

EPIDEMIOLOGY AND GENOMICS RESEARCH PROGRAM

Selected Projects in Dietary Assessment Research

- Automated Self-Administered 24-Hour (ASA24) Dietary Assessment Tool: ASA24 is a freely available web-based tool from NCI for epidemiologic, interventional, behavioral, or clinical research that enables multiple automatically coded, self-administered 24-hour recalls and food records. The ASA24 system will have an optional sleep module that was made available in late 2021. The sleep module can be used to examine the relationship between diet, sleep, and timing of eating occasions, including intermittent fasting.
- Catalogue of Surveillance Systems: This website provides one-stop access to more than 100 publicly available data sets relevant to childhood obesity research. The catalogue was developed by the National Collaborative on Childhood Obesity Research, a public–private partnership supported in part by NIH.
- Diet History Questionnaire (DHQ)**:** The DHQ is a free food-frequency questionnaire developed by NCI staff for use by researchers, clinicians, and educators.
- Dietary Assessment Primer: This resource helps researchers determine the best way to assess diet for any study in which estimates of group intake are required.

- Healthy Eating Index (HEI): The HEI is a measure of diet quality, independent of quantity, that can be used to assess compliance with the Dietary Guidelines for Americans and monitor changes in dietary patterns.
- Measures Registry Resource Suite: The Measures Registry Resource Suite, developed through a public–private partnership between CDC, NIH, Robert Wood Johnson Foundation, and USDA, offers research tools spanning four domains of childhood obesity research: diet, physical activity, the food and physical activity environments. It includes the Measures Registry, Measures Registry User Guides, Measures Registry Learning Modules, and Measures for Children at High Risk for Obesity Decision Tree.
- World Cancer Research Fund (WCRF)/American Institute for Cancer Research (AICR) Score: The 2018 WCRF/AICR Score is a standardized scoring system that can be used by researchers to assess adherence to the 2018 WCRF/AICR Cancer Prevention Recommendations and examine associations with cancer-related and other health outcomes.
- Health Behaviors Research Branch**:** The Health Behaviors Research Branch aims to support research at multiple levels of analysis to improve cancer-related health behaviors and risk factors.
- The Classification of Laws Associated with School Students (CLASS)**:** CLASS protects the well-being of students by monitoring, classifying, and evaluating physical education and nutrition policies across the United States.
- Metabolic Epidemiology Branch**:** The branch's research mission is to conduct collaborative, high-impact epidemiological research on metabolic and lifestyle causes of cancer that will guide prevention and early intervention strategies worldwide.
- Nutritional Science Research Group (NSRG)**:** The NSRG promotes and supports studies establishing a comprehensive understanding of the precise role of diet and food components in modifying cancer risk and tumor cell behavior.
- Trans-NCI Obesity and Cancer Working Group: The purpose of the workgroup is to promote the exchange of information and crosscutting interests in obesity and cancer research within NCI.
- Diet, Weight, Physical Activity, and Sleep Working Group: The purpose of the workgroup is to promote integrated discussion and exchange of information in the scientific areas of diet, weight, physical activity, and sleep at NCI.
- Risk Factor Assessment Branch (RFAB): RFAB develops, supports, and stimulates assessment of modifiable risk factors among individuals and diverse populations across the cancer continuum to inform and advance health promotion.

RESEARCH DIRECTIONS

NCI supports extensive research on the relationship between nutrition and cancer in a wide variety of areas spanning the prevention, therapy, and survivorship domains, including studies that focus on basic molecular and cellular mechanisms of action of bioactive food components, dietary assessment methods, etiology, risk factor monitoring, and development of evidence-based interventions. Among the many research approaches being pursued or encouraged, the following are of particular importance.

Dietary Assessment Methods

- Innovative and novel technologies for assessing diet, physical activity, sleep, and weight control behaviors—such as the ASA24 Dietary Assessment Tool, electronic handheld monitoring devices, and digital technologies—that are approached in collaboration with other NIH institutes
- Identification and validation of biomarkers of dietary intake to assess the accuracy of dietary assessment methods commonly used in epidemiology, intervention, and surveillance research
- Improved diet, physical activity, and sleep assessment methodologies across culturally diverse populations
- Studies to examine patterns of multidimensionality and dynamism of diet, including diurnal patterns and patterns over the life course

Molecular Targets for Bioactive Food Components

- Preclinical and clinical studies using genomic, epigenomic, proteomic, and metabolomic approaches to identify critical bioactive food components and their sites of action in the cancer process
- Clinical studies to characterize inter-individual variability in biological responses to diet and how responses influence cancer risk and prevention

- New approaches to integrate omic information to understand consumption of specific nutrients and foods and/or dietary patterns and biological responses related to cancer pathways
- Preclinical and clinical studies to understand the interplay between nutrition, the microbiome, immune function, and cancer prevention
- Clinical studies to examine biological effects of microbial-generated metabolites from food components and their role in cancer prevention, etiology, and cancer health disparities
- Clinical and mechanistic studies on the effects of prebiotics and probiotics found in food or food components; their interaction with members of the gut, mouth, and skin microbiota; and their role in carcinogenesis and metabolism
- Essential and nonessential food components as modifiers of carcinogen metabolism, DNA repair, cell proliferation, differentiation, immunocompetence, hormonal homeostasis, and apoptosis
- Novel technologies for evaluating metabolic profiles, genetic susceptibilities, and predispositions to cancer as influenced by diet
- Transdisciplinary research to discover and characterize mechanisms by which diet, weight, physical activity, and sleep interact with genetic and other factors in cancer development and progression
- Food preparation and processing methods—as well as variation in food, alcohol, fat, and fiber intake—as modifiers of biomarkers or tumor incidence
- Interdependence of obesity, physical activity and sedentary behaviors, sleep, and inflammatory responses in establishing cancer risk and tumor behavior through various epidemiologic, clinical, and preclinical investigations
- Physiological responses to defined dietary patterns, including time-related eating patterns, to determine their role in cancer incidence and tumor behavior
- Studies that examine psychosocial, generational, and environmental correlates of cancer-related behaviors, including diet, physical activity, sleep, and tobacco use
- Investigation of the mechanisms by which diet and nutritional interventions and physical activity affect the response to cancer treatment, symptom management, or cancer recurrence
- Nutritional requirements of the cancer patient and neoplastic tissues, with emphasis on nutrient uptake, utilization, and cellular control mechanisms in both normal and neoplastic tissues and on host–tumor interactions and competition for nutrients

Population Surveillance, Economics, and Policy

- Population-level monitoring of diet and other risk factors for the refinement of nationwide surveys, such as the National Health Interview Survey and National Health and Nutrition Examination Survey
- Cohort Consortium to collect enhanced self-report and objective measures on diet and bioactive food components
- Collaboration with the National Center for Health Statistics on nationwide surveys to enhance self-report, biologic, and genetic measures for monitoring and examining the impact of behaviors related to energy balance and cancer
- Public comprehension of health recommendations on diet and physical activity through the NCI Health Information National Trends Survey
- NIH-wide initiative to support innovative economic research on diet, physical activity, and energy balance to examine societal, market, and economic forces that may influence nutrition and related practices, particularly in at-risk populations
- Private–public initiatives to develop research resources to track legislation and policies related to diet, physical activity, and weight control to assist in the understanding of factors influencing decisions at the population level and within clinical practice

Development of Evidence-Based Interventions

- Transdisciplinary research to develop effective, innovative approaches with broad population impact at the social, environmental, and policy levels for prevention of obesity-related cancers

- Clinical dietary intervention trials related to specific diets, nutrients, foods, and food components and their effects on cancer incidence and tumor behavior
- Genomic technologies to identify those who respond maximally to dietary intervention and those who might be at risk for poor cancer health outcomes due to diet and nutritional alterations
- Cost-effective approaches using food components for prevention and therapeutic strategies within clinical interventions
- Clinical trials to evaluate the effectiveness of nutritional support in the rehabilitation of the cancer patient, nutrition requirements during the spectrum of cancer care, and nutrient and dietary factors needed to maximize patient survival
- Clinical trials to assess the effects of diet and weight loss on cancer recurrence
- Research to understand the effects of intermittent fasting patterns on health and disease
- Behavioral research to identify evidence-based behavioral approaches for improving diet, physical activity, and weight management practices
- Systems research to assess the effects of the built environment on food access and dietary behaviors on cancer risk
- Research methodologies for improved empirical study of cancer-relevant behaviors (e.g., diet, physical activity, energy balance, and environmental exposures) and the relationships to the psychosocial and built environments (e.g., measures of psychosocial correlates of eating patterns and physical activity and of the obesogenic environment, along with food consumption and dietary related biomarkers and the interaction between the environment and psychosocial factors associated with cancer-preventive health behaviors)

National Center for Complementary and Integrative Health

https://www.nccih.nih.gov

OVERVIEW

The National Center for Complementary and Integrative Health (NCCIH) is the lead federal agency for scientific research on the fundamental science, usefulness, and safety of complementary and integrative treatments and practices. To address the need for objective evidence on the safety and efficacy of these approaches, NCCIH supports rigorous scientific investigation to better understand how these interventions impact health and for whom and identify the optimal methods of practice and delivery.

NCCIH supports research on a diverse group of nondrug and noninvasive health practices encompassing nutritional, psychological, and physical approaches that may have originated outside of conventional medicine, many of which are gradually being integrated into mainstream health care. These include natural products—such as dietary supplements, plant-based products, and probiotics—and mind and body approaches, such as yoga, massage therapy, meditation, mindfulness-based stress reduction, spinal/joint manipulation, and acupuncture. In clinical practice, these approaches are often combined into multicomponent therapeutic systems—such as traditional Chinese medicine, Ayurveda, chiropractic, osteopathy, and naturopathy—that have distinctive underlying diagnostic and theoretical frameworks. Integrative health care seeks to bring conventional and complementary approaches together in a safe, coordinated way with the goal of improving clinical care for patients, restoring health, promoting resilience, and preventing disease.

Establishing priorities across the field of complementary and integrative health research is enormously challenging. NCCIH-supported research clearly intersects with nutrition, as is exemplified by the NCCIH's robust natural products research portfolio, which includes research on dietary supplements, herbal and botanical products, probiotics, and food-based phytochemicals. NCCIH also supports research on certain types of diets (e.g., ketogenic). The center's research on natural products relies heavily on the methods and tools of pharmacology and pharmacognosy. NCCIH has established rigorous standards and policies for the quality and integrity of products used in NCCIH-supported research. Further information on the NCCIH policy on the integrity of natural products is available on the center's website.

KEY ACHIEVEMENTS

New Analysis Confirms Benefit of Supplements for Slowing Age-Related Macular Degeneration

Substituting lutein and zeaxanthin for beta-carotene in a dietary supplement that slows the progression of age-related macular degeneration (AMD) increased the supplement's effectiveness and reduced the risk of lung cancer due to beta-carotene, according to a follow-up analysis of a large clinical trial. This new report, which analyzed 10 years of data from the Age-Related Eye Disease Study 2 (AREDS2), was funded by the National Institutes of Health and published in *JAMA Ophthalmology*.[1]

AMD, the most common cause of blindness in older Americans, is a degenerative disease of the retina, the light-sensitive tissue at the back of the eye. Progressive death of retinal cells in the macula, the part of the retina that provides clear central vision, eventually leads to blindness. Treatment can slow or reverse vision loss; however, no cure for AMD exists.

The original Age-Related Eye Disease Study (AREDS), launched in 1996, showed that a dietary supplement formula of 500 mg vitamin C, 400 international units vitamin E, 2 mg copper, 80 mg zinc, and 15 mg beta-carotene could significantly slow the progression of AMD from moderate to late disease. However, two concurrent but unrelated studies revealed that people who smoked and took beta-carotene supplements had a higher risk of developing lung cancer.

The AREDS2 clinical trial, which began in 2006, compared a formula with 10 mg lutein and 2 mg zeaxanthin in place of beta-carotene with the original beta-carotene formulation. Because beta-carotene had been shown to be harmful to smokers, formulations containing beta-carotene were given only to people who had never smoked or who had quit smoking. At the completion of the 5-year study period, all participants were provided the AREDS2 supplements with lutein and zeaxanthin, vitamins C and E, zinc, and copper.

[1] https://pubmed.ncbi.nlm.nih.gov/35653117

For this new analysis, 3,883 of the original 4,203 AREDS2 participants were contacted by phone between December 1, 2012, and December 31, 2018. The researchers collected information on whether the participants' AMD had progressed to late disease and whether they had been diagnosed with lung cancer.

Although all participants had switched to the lutein and zeaxanthin formula at the end of the trial, the follow-up study showed that beta-carotene nearly doubled the risk of lung cancer for those who had ever smoked and there was no increased risk of lung cancer in those receiving lutein and zeaxanthin. Furthermore, after 10 years, the group originally assigned to receive lutein and zeaxanthin had an additional 20 percent reduced risk for late AMD progression compared to those who received beta-carotene. The researchers who conducted the new analysis concluded that lutein and zeaxanthin are an appropriate replacement for beta-carotene that is safe and effective for long-term use.

RESEARCH DIRECTIONS

The NCCIH's new strategic plan lays the groundwork to build on its 20-year portfolio of research on dietary supplements and natural products by framing nutrition research within a wider, more inclusive landscape. This approach recognizes that nutrition connects deeply with physical and psychological health and allows the Center to consider research that can probe into multiple, overlapping areas of study.

NCCIH research priorities are guided by its strategic plan, which has the following primary research objectives:

- Advance fundamental science and methods development.
- Advance research on the whole person and on the integration of complementary and conventional care.
- Foster research on health promotion and restoration, resilience, disease prevention, and symptom management.
- Enhance the complementary and integrative health research workforce.
- Provide objective, evidence-based information on complementary and integrative health interventions.

NCCIH has a broad interest in studying the biological activities of such natural products as prebiotics, probiotics, dietary supplements, botanicals, and vitamins. A strong research emphasis is placed on products for which there is compelling preclinical evidence of potential biological activity that may lead to a health benefit or treatment intervention and on products that are widely used by the American public. Many of the natural products used by individuals are complex, with multiple molecular constituents that may contribute to their effects. To fully understand the activity of complex mixtures, it is necessary to identify the individual components responsible for a specific activity and determine how those components interact with other components and biological targets. Preclinical model systems are valuable for these studies. Clinical trials of natural products are maximally informative if they incorporate well-formulated biological hypotheses, are built on a sound foundation of basic mechanistic and pharmacologic understanding, and incorporate an assessment of defined signatures of biological effects. Thus, the design of maximally informative clinical efficacy trials of natural products requires mechanistic insight as a first step.

NCCIH will continue to support research on isolated natural product compounds and the complex mixtures from which they originate. Studies also may focus on both the potential effects of natural products, both beneficial and harmful, including their interactions with medications. NCCIH-supported studies also may include the characterization of novel natural products or the discovery of the biological activity of chemical constituents in a complex mixture.

Historically, NCCIH has supported most basic and translational research and development activities relevant to complementary approaches in natural products research through investigator-initiated research grants. This is augmented with targeted initiatives to address high-priority research topics. Solicitations across the broad spectrum of NCCIH's research may be found on the center's website. This broad-based approach has yielded a robust pipeline of basic to clinical research, as well as a large body of information and promising leads for future research. For example, NCCIH is supporting a Center of Excellence for Natural Product Drug Interaction Research that is focused, in part, on conducting rigorous human subject studies to establish the clinical relevance of interactions for selected natural products. NCCIH also supports rigorous screening of natural product libraries in assays with clear relevance to human metabolism for evidence of pharmacokinetic interactions. The data generated will provide additional information on potential interactions and help inform prioritization strategies regarding which natural products may warrant future investments in clinical studies.

NCCIH also will continue to support research to elucidate the effects of probiotics and prebiotics on the microbiota naturally present in the human body. The center seeks to address fundamental knowledge gaps, including those pertaining to molecular mechanisms of action of the microbiota and potential interactions with pre- and probiotics and their impact on processes in the human body. NCCIH will continue to work closely with other NIH institutes, centers, and offices—including the Office of Nutrition Research and Office of Dietary Supplements—as well as with the U.S. Department of Agriculture and U.S. Food and Drug Administration to leverage its investments in this research area.

NUTRITION TRAINING

NCCIH supports four T32 training programs relevant to nutrition research:

Botanical Approaches to Combat Metabolic Syndrome
Pennington Biomedical Research Center, Louisiana State University (LSU)
Baton Rouge, LA

The objective of this proposed training grant is to train both Ph.D. and M.D. postdoctoral fellows to become productive research scientists capable of establishing scientific careers that further efforts to understand the role of botanicals on the complex interactions between genetic, molecular, and physiological aspects of metabolic syndrome. Many qualified scientists in the areas of molecular biology, genetics, physiology, and metabolism have been attracted to the study of metabolic syndrome but lack the expertise or resources to expand their research to the study of how botanicals may affect these physiologic or molecular processes. Conversely, individuals who may be well versed in plant discovery, characterization, and standardization may need to have their approach complemented by molecular, genetic, and physiologic approaches. We aim to bridge the divide between the plant discovery/characterization approach and the molecular biology/physiology approach by providing training in these areas and by encouraging postdoctoral interdisciplinary research efforts to understand the effect and action of botanicals on components of the metabolic syndrome. This training program will take advantage of the staff and resources of our NIH-sponsored Botanicals Research Center, a joint venture between Pennington Biomedical Research Center, the LSU Agricultural Center, and the Rutgers University Biotechnology Center for Agriculture and the Environment. Most fellows will be based in Baton Rouge, Louisiana, but some will be based in New Brunswick, New Jersey. Live video conferencing, secure internet access, and visits to all training sites will allow for multidisciplinary training. Along with laboratory mentoring, fellows will complete formal coursework, seminars in grant writing, and training in the responsible conduct of research.

Innovative Technologies for Natural Products and Integrative Medicine
The University of North Carolina (UNC) at Greensboro
Greensboro, NC

This program supports four predoctoral trainees pursuing their Ph.D. in the UNC Greensboro Department of Chemistry and Biochemistry. The program is part of UNC Greensboro's Medicinal Chemistry Collaborative, a network of investigators who collaborate on basic science projects with the ultimate goal of improving health. The trainees prepare for independent careers by participating in mentored laboratory research, coursework, seminars, and internships. They conduct, present, and publish research in complementary and integrative health, natural products discovery, and technology advancement. An important element of this work is hands-on training in UNC's outstanding nuclear magnetic resonance and mass spectrometry facilities, where trainees design experiments, operate instrumentation, and carry out data analysis. The program has a strong commitment to diversity and inclusiveness, and both mentors and trainees participate in multiple outreach programs to provide STEM education opportunities to young people, particularly those from groups historically underrepresented in the sciences.

Research Training in Natural Product Complementary and Alternative Medicine
University of Illinois Chicago (UIC)
Chicago, IL

This training grant currently supports six predoctoral trainees working towards a Ph.D. in natural products research. The Department of Medicinal Chemistry and Pharmacognosy (MCP) and the Program for Collaborative Research in the Pharmaceutical Sciences (PCRPS) have been leading programs in natural products research and graduate education, in particular through the pharmacognosy graduate program. This highly collaborative training environment involves two natural product centers, the UIC/NIH Center for Botanical Dietary Supplements Research and the Center for Natural Product Technologies (CeNAPT), as well as

numerous collaborative, NIH-funded research projects. Faculty in the program are world-renowned natural products researchers who support the mission and serve as mentors on this training grant. For over four decades, PCRPS has acquired a global reputation of excellence in graduate education and postgraduate training, with hundreds of alumni worldwide. The signature of this program is its emphasis on interdisciplinary and collaborative approaches to graduate education in natural products of biomedical relevance. The PCRPS incorporates UIC's pharmacognosy graduate program, a postdoctoral and scholarly training and exchange program in pharmacognosy that includes the UIC–World Health Organization Traditional Medicines Collaborating Center, and medicinal chemistry graduate and postgraduate training with a focus in natural products. The UIC/NIH Center for Botanical Dietary Supplements Research evaluates the safety and efficacy of botanical dietary supplements that are used widely by menopausal women in the United States. CeNAPT has further expanded these educational opportunities for trainees. Mentored by well-funded faculty with expertise in natural products research, graduates move on to leadership positions in academia, industry, regulatory, and government here in the United States and all over the world. Training young scientists for careers in natural products research is a core mission of the College of Pharmacy, jointly provided by the MCP Department, PCRPS, and the Botanical and CeNAPT centers.

Natural Products Research Training in Complementary and Integrative Health
Oregon State University (OSU)
Corvallis, OR

Founded in 1898, the OSU College of Pharmacy is one of the oldest in the United States and has been a leader in natural products research and education since the predoctoral training program in pharmaceutical sciences began in 1952. Founded in 1973 by two-time Nobel laureate Linus Pauling and housed in the state-of-the-art Linus Pauling Science Center on the OSU campus, the Linus Pauling Institute is focused on using micronutrients, phytochemicals, and dietary supplements to prevent disease and maintain human health. The institute's graduates occupy leadership positions in academia, industry, and government in the United States and throughout the world. Historically, natural products have accounted for over half of all therapeutic agents, and today are still the inspiration for nearly 40 percent of new drugs. Training young scientists for careers in natural products and dietary supplements research is a core mission of the College of Pharmacy and the Linus Pauling Institute and is the focus of this training grant. To address the need to train a new generation of experts in research concerning natural products drug discovery and in the safety and efficacy of dietary supplements, this T32 training grant program supports five predoctoral trainees at a time. The mentor team includes faculty with expertise in marine, microbial, and botanical natural products and dietary supplements, as well as natural product genomics, cancer therapy, chemoprevention, pharmacology, dietary supplements, organic synthesis, and biosynthesis. The leadership team includes co-Program Leaders with experience leading a T32 training program (Dr. Richard van Breemen) and experience serving as a director of graduate studies for the department (Dr. Taifo Mahmud). Finally, the OSU training program is enhanced by exceptional institutional commitment in the forms of administrative support from the College of Pharmacy, Department of Pharmaceutical Sciences, and the Linus Pauling Institute and financial support from the OSU Graduate School.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

Teaching Kitchen Research Conference

The Harvard T.H. Chan School of Public Health Department of Nutrition and the Teaching Kitchen Collaborative hosted the 2022 Teaching Kitchen Research Conference with co-sponsorship from NCCIH. The conference highlighted the latest in emerging research on the application and impact of teaching kitchens across multiple populations and settings and included the following topics:

- The intersection of teaching kitchens with precision nutrition; health equity; and culinary, lifestyle, and integrative medicine. There was also a discussion as to who will pay for teaching kitchens.
- The impact organizations with teaching kitchens are having in hospitals, universities, K–12 schools, worksites, libraries, YMCAs, and botanical gardens and as shared assets in community settings
- How teaching kitchens are being used in shared medical appointment settings and the business case for supporting teaching kitchens

» A visit to the new teaching kitchen facility at the University of California, Los Angeles, with talks from chef instructors, dietitians, physicians, and researchers on effective models of culinary instruction

Expanding Translationally Relevant Chemical Space: Insights into Natural Product Resources, Technologies, and Mechanisms
This webinar series was hosted by NCCIH in collaboration with other NIH institutes and centers in 2023.

Leading researchers discussed current work on the discovery and characterization of natural products, including the use of state-of-the-art tools and techniques. During the webinars, experts in the natural products field touched on topics in organic structure analysis, metabologenomics, venomics, high-throughput phenotypic screening, electron microscopy techniques, host–microbe interactions, and structural biology. Representatives of different institutes and centers explained how natural products research fits in with their respective research priorities.

Precision Probiotic Therapies—Challenges and Opportunities
Probiotic interventions may offer beneficial effects, such as alleviation of gastrointestinal symptoms, "strengthening" of the immune system, protection against infectious diseases, prevention of metabolic disorders, improved mental health, promotion of early development, and general well-being. However, one major challenge in assessing the effects of probiotic interventions has been the inconsistent results of clinical trials. Research has yielded a better understanding of some of the biological and behavioral factors that might contribute to inconsistent outcomes from probiotic interventions (e.g., differences in gut microbiota, diet, age, lifestyle). Innovative research approaches are needed to understand the contributions and interactions of these factors and to advance methods for their assessment. The probiotics literature shows growing interest in the development of individualized microbial therapeutics for targeted interventions, but wide gaps in knowledge still need to be addressed.

The goals of this NCCIH-sponsored workshop were to (1) identify gaps in the current understanding of the biology of the gut microbiota and of probiotics, and (2) identify research questions and methodological challenges posed by those gaps. Knowledge developed through these activities will provide a critical foundation for future research efforts to develop "precision probiotic therapies."

National Eye Institute

https://www.nei.nih.gov

OVERVIEW

The mission of the National Eye Institute (NEI) is to eliminate vision loss and improve quality of life through vision research. To achieve this mission, NEI provides leadership to achieve the following:

- Drive innovative research to understand the eye and visual system, prevent and treat vision diseases, and expand opportunities for people who are blind or require vision rehabilitation.
- Foster collaboration in vision research and clinical care to develop new ideas and share knowledge across other fields.
- Recruit, inspire, and train a talented and diverse new generation of individuals to expand and strengthen the vision workforce.
- Educate health care providers, scientists, policymakers, and the public about advances in vision research and their impact on health and quality of life.

RESEARCH DIRECTIONS

- The NEI Strategic Plan identified research opportunities in both ocular and gut microbiome research. Age-related macular degeneration (AMD) is a complex disease involving the interactions of genes and environmental factors, with diet, age, metabolome, and the gut microbiome playing strong roles. Rodent models have demonstrated communication axes between the gut microbiome and eye immunobiology. In humans, epidemiological data suggest that fish, fruits, vegetables, and a low-glycemic diet are beneficial for aging eye health.
- An analysis of epidemiologic data from the AREDS2 study suggested that a Mediterranean diet significantly slowed the progression of dry AMD, as measured by the area of geographic atrophy (GA) lesions over 3 years of follow-up. In GA, death of retinal cells near the macula leads to vision loss. Mediterranean diets were associated with more protection against both faster progression to GA and faster enlargement of GA.
- The AREDS2 dietary supplement formulation replaced beta carotene from the AREDS formulation with lutein/zeaxanthin. A recently published long-term epidemiologic follow-up assessed the risk of developing lung cancer and late AMD. Beta carotene usage nearly doubled the risk of lung cancer, whereas there was no statistically significant increased risk with lutein and zeaxanthin. When compared with beta carotene, lutein and zeaxanthin had a potential beneficial association with late AMD progression.
- Macular pigment (MP) is composed of the dietary carotenoids lutein, zeaxanthin, and meso-zeaxanthin and declines with age. NEI scientists are investigating MP as a modifiable risk factor for AMD and how preserving MP might help reduce risk of developing eye diseases and vision loss.
- Carotenoid levels are known to vary by individual and are influenced by such factors as dietary sources, total nutrient intake, vitamin supplementation, genetics, and metabolism. After 15 years of follow-up with a cohort of women who participated in the Women's Health Initiative (WHI), NEI-supported researchers observed that higher carotenoid levels were associated with larger retinal vessels, indicating a clinically significant relationship between carotenoid levels and incidence or progression of age-related eye disease, specifically macular degeneration.
- Primary open-angle glaucoma, a leading cause of irreversible blindness that disproportionally impacts Black and Hispanic individuals, is characterized by the death of retinal ganglion cells (RGC) and their axons in the retinal nerve fiber layer (RNFL). The NEI-funded Carotenoids in Age-Related Eye Disease Study 2 (CAREDS2), an ancillary study to WHI, followed participants 15 years from baseline to compare the amount of macular pigment (quantified anatomically) with thickness of RGC and RNFL. In individuals both with and without manifest glaucoma, they discovered macular pigment and RGC/RNFL were positively correlated, suggesting that interventions to increase macular pigment may prevent glaucoma development or progression.
- Epidemiologic data from AREDS and AREDS2 enabled comparisons of nutrient diet and altered cognitive function. Higher dietary intake of 4 of 48 nutrients (AREDS) and 13 of 44 (AREDS2)—including specific vitamins, minerals, carotenoids, fatty acids, and fiber—was associated with lower risk of cognitive impairment but not slower decline in cognitive function.

- On the developmental end of the spectrum, evidence indicates that pregnant women actively transport carotenoids via the placenta, yet lutein and zeaxanthin are rarely incorporated into prenatal vitamins. A recent randomized clinical trial, Lutein and Zeaxanthin in Pregnancy (L-ZIP), demonstrated that the mother's ocular and systemic carotenoid status strongly influences her newborn's ocular and systemic carotenoid status. Premature, low birth weight infants are at high risk for retinopathy of prematurity (ROP), a leading cause of ocular blindness in children. An NEI study in mouse models demonstrated that prenatal supplementation of carotenoids was protective against retinopathy. Together, these results suggest that the benefits of carotenoids against ROP should be revisited and recommend testing prenatal carotenoid supplementation in future human clinical trials.
- Dry eye disease (DED) affects approximately 14 percent of the U.S. population, and it is common practice for DED patients to take supplements as part of their treatment. The Dry Eye Assessment and Management (DREAM) study is an NEI-funded, randomized trial that investigated the effects of omega-3 fatty acid (fish oil) supplementation on DED patients across 27 U.S. sites. DREAM investigators found that fish oil supplements are no better than placebo. Ongoing secondary data analyses of DREAM data have identified important systemic risk factors for DED.
- Cocoa products contain epicatechins, a subclass of flavonoids that have potential benefits on vasodilation and blood pressure. NEI has funded the COcoa Supplement and Multivitamins Outcomes Study (COSMOS) eye trial to examine the efficacy of cocoa extract supplements in reducing the risk of AMD and cataract development in a cohort of patients who are participating in the COSMOS trial.
- NEI has funded research investigating vitamin D metabolism in the cornea and in tear fluid. Although vitamin D is predominantly produced in the skin in response to ultraviolet sunlight, the cornea also may produce it. Vitamin D may have many roles in the eye, from healing wounds to controlling intraocular pressure. In a prespecified ancillary study to the VITamin D and OmegaA-3 TriaL (VITAL), NEI investigators found that after 5 years of follow-up, neither daily supplementation with vitamin D nor daily supplementation with omega-3 fatty acids had a significant overall effect on AMD incidence or progression.
- Vitamin A is the precursor for 11-cis-retinal, a molecule essential for vision. Investigations into vitamin A, its derivatives, and the proteins that bind and transport it to cells are a major focus of NEI-supported research. Scientists are exploring the role these substances play in the normal metabolism of ocular tissues and in the visual cycle. Increasing evidence shows the importance of vitamin A derivatives and their binding proteins as potential therapeutic targets. Researchers have found that chronic deficiency of vitamin A has an effect on ocular tissue integrity and metabolism.

National Heart, Lung, and Blood Institute

https://www.nhlbi.nih.gov

OVERVIEW

The mission of the National Heart, Lung, and Blood Institute (NHLBI) is to provide global leadership for a research, training, and education program to promote the prevention and treatment of heart, lung, and blood diseases and enhance the health of all individuals so that they can live longer and more fulfilling lives. Optimal nutrition undergirds the prevention, management, and mitigation of heart, lung, blood, and sleep (HLBS) diseases and disorders and the promotion of overall health across the lifespan.

KEY ACHIEVEMENTS

- **Workshop on Advancing Health Equity Through Culture-Centered Dietary Interventions to Address Chronic Diseases (September 28–29, 2023):** This workshop convened researchers, health care providers, community representatives, and government officials to discuss the pivotal role of culture in dietary interventions aimed at diverse populations underrepresented in health research. The workshop identified key research gaps and future opportunities to stimulate nutrition science. For more information, see the workshop website.
- **Workshop on Chrononutrition: Elucidating the Role of Circadian Biology and Meal Timing in Cardiometabolic Health (May 2–3, 2023):** The workshop aimed to explore the connection between circadian rhythms and nutrition as it relates to the development of cardiometabolic disease. Academic and clinical investigators discussed emerging research linking circadian and nutrition science and identified opportunities to apply these discoveries to clinical practice to improve prevention, treatment, and health outcomes. Chrononutrition is an emerging field with great promise for improving cardiometabolic health outcomes across populations. New technologies and digital platforms are crucial tools for data collection and development of equitable and individualized interventions. Further study of the interplay among meal-timing, sleep quality, and exercise schedules is needed before the data collected can be used to develop revised dietary guidelines. This NHLBI-wide workshop is aligned with the goals of the NIH Common Fund's Nutrition for Precision Health, powered by the *All of Us* Research Program; the NHLBI Nutrition Research Implementation Plan; and the new NIH Sleep Research Plan. Recordings for both Day 1 and Day 2 are available on NIH VideoCast.
- **Early Intervention to Promote Cardiovascular Health of Mothers and Children (ENRICH) Program:** The goal of ENRICH is to test the effectiveness of an implementation-ready intervention, delivered in the context of early childhood home visiting, to promote and address disparities in maternal and early childhood cardiovascular health. Mother-child dyads will be enrolled across seven clinical centers across the United States in partnership with local programs implementing evidence-based home visiting programs: Healthy Families America, Parents as Teachers, Nurse Family Partnership, and Family Check-Up. ENRICH addresses the American Heart Association's Life's Essential 8 factors, of which diet and nutrition are major components. The intervention is tailored and targeted to mother-child dyads and their social determinants of health needs and addresses health equity by "meeting clients where they are." ENRICH was developed in partnership with several NIH ICOs (NIDDK, NIMHD, ODP, OBSSR, ORWH) and other federal agencies, including the Health Resources and Service Administration (HRSA) and the Administration for Children and Families (ACF). The 7-year program is in its second year and will run through fiscal year 2028. The study protocol has been approved by the NHLBI-initiated Data and Safety Monitoring Board.

Future directions of interest to NHLBI include Food is Medicine, nutrition security, precision nutrition (including nutrition metabolomics), and chrononutrition. Example initiatives, funded research, and future initiatives can be found below.

Current Initiative

- **Notice of Special Interest (NOSI)—Stimulating Research to Understand and Address Hunger, Food, and Nutrition Insecurity:** NHLBI is particularly interested improving the understanding of the mechanisms linking food and nutrition insecurity to diseases and conditions relevant to heart, lung, blood, and sleep. Additionally, NHLBI aims to stimulate intervention research to address food or nutrition security, including the neighborhood food environment. See the NOSI for more information.

Examples of Funded Studies

- **Nutrition Metabolomics (**R01HL153178**):** In the NHLBI-funded study "Discovery, Replication, and Validation of Biomarkers of the Dietary Approaches to Stop Hypertension (DASH) Diet and Hypertension," researchers are using untargeted metabolomics, untargeted proteomics, and targeted quantitative assays to discover, replicate, and validate novel biomarkers of the DASH dietary pattern to characterize metabolic pathways underlying the beneficial cardiovascular health effects of this diet.
- **Culturally Appropriate Dietary Interventions (**R01HL163714**):** In this Type 2 hybrid effectiveness-implementation trial, the research team is exploring the effectiveness of a culturally tailored vegan diet—the Nutritious Eating with Soul intervention (NEW Soul)—for African Americans with overweight or obesity.

Future Initiative

- **Advancing PREcision Nutrition-Based InterVENTion (PREVENT) Research Initiative:** This initiative includes the objective to advance research in precision nutrition to promote HLBS health and address health equity. The ultimate goal is to reduce diet-related disparities in cardiovascular, cardiopulmonary, and other related HLBS diseases and conditions and promote health equity. This initiative is spurred by the *Strategic Plan for NIH Nutrition Research* and has the potential to leverage the NIH Common Fund's Nutrition for Precision Health, powered by the *All of Us* Research Program. It is stimulated by two recent NHLBI-led workshops: (1) The Science of Precision Prevention: Research Opportunities and Clinical Applications to Reduce Cardiovascular Health Disparities and (2) Advancing Health Equity Through Culture-Centered Dietary Interventions to Address Chronic Diseases.

Future Workshops

- Advancing Nutrition Research to Promote Respiratory Health (October 2024)
- Maternal and Perinatal Nutritional Programming of Lung Health in Childhood and Early Adulthood (Fall 2024)

Future Collaborations

- **National Health and Nutrition Examination Survey (NHANES):** NHLBI is collaborating with the Centers for Disease Control and Prevention on NHANES data collection to include dietary assessment and other measures, including actigraphy to assess sleep and physical activity, blood pressure measurement in children ages 3 to 7 years, and pulmonary function using spirometry and lipid panel. Such data could enable studies to assess the associations of diet and nutrition with cardiovascular and cardiopulmonary health metrics.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

Seminars and Workshops on Obesity Nutrition and Physical Activity

- The Role of Teaching Kitchens in Addressing Nutritional Disparities and Implementation Research: In this seminar, NIH intramural investigator Dr. Nicole Famer presented research on the role of cooking interventions on dietary behaviors and cardiovascular outcomes.
- New Directions in Community-Based Interventions to Improve Food Access and Reduce Obesity in Baltimore: In this seminar, Johns Hopkins University researcher Dr. Joel Gittelsohn discussed his most recent research working at multiple levels of the food system, including new food sources (e.g., restaurants, food pantries), and using technology in an effort to expand the reach and sustainability of his research.
- Dietary Biomarkers and Cardioprotective Mechanisms of the DASH Diet: In this seminar, Dr. Casey M. Rebholz discussed biomarkers as an objective approach to assess dietary intake and reviewed the findings on metabolomic and proteomic biomarkers of the DASH dietary pattern from observational studies and clinical trials.
- Intermittent Fasting and the Circadian Clock: Does When You Eat Affect Your Health? In this seminar, Dr. Courtney M. Peterson discussed circadian rhythms and their role in metabolism and cardiovascular health, focusing on findings and current knowledge regarding time-restricted eating.
- Optimal Instruments to Measure Diet, Physical Activity, and Sleep (September 21–22, 2022)

» Health and Aging Trajectories: Shared and Competing Risks and Resiliencies for Chronic Diseases Associated with Aging (September 28–29, 2023)

» Promoting Cardiovascular Health of Youth in the Juvenile Justice System and Their Transitions Outside of the System (February 22–23, 2022)

TOOLS AND RESOURCES

The Trans-Omics for Precision Medicine (TOPMed) Program has assembled one of the world's largest, most diverse collections of genomic and multiomic data, including nutrition-related data, derived from participants in NHLBI-funded studies.

For several consecutive years, the DASH eating plan has been named one of the best diets by *U.S. News & World Report*. DASH supports overall heart health and helps lower blood pressure and cholesterol. Additionally, the award-winning Therapeutic Lifestyle Changes (TLC) is a three-part program created to improve cholesterol numbers.

National Human Genome Research Institute

https://www.genome.gov

OVERVIEW

Since the completion of the Human Genome Project in 2003, National Human Genome Research Institute (NHGRI)–supported research has focused on advancing genomic science and medicine through a deeper understanding of genome structure and function; the relationships between genes, environment, and human health; and attitudes and behaviors related to genomic information.

As part of its mission to advance genomic science and medicine, NHGRI funds research on the complex relationships between genomics and nutrition-relevant variables. Genomics plays an essential role in individual variation in metabolism and predisposition for genetically complex diseases, including obesity, diabetes, heart disease, and cancer. NHGRI supports studies to investigate the interplay between genetic and environmental risk factors for these complex diseases in multi-ethnic cohorts. In addition, NHGRI funds research on how people understand and use genomic information related to obesity risk to shape food and nutrition choices.

KEY ACHIEVEMENTS

NHGRI intramural researchers used new mitochondrial genome sequencing methods to study how diet, specifically the amount of vitamin B12 and folate, affects mutation rates. The researchers found that vitamin B12 deficiency increased the number of mutations in the mitochondrial genomes of the mice, and that this was especially true for older mice.

In fiscal year 2022 (FY22), NHGRI intramural researchers published a study demonstrating that education on gene-by-environment interactions that underlie eating behaviors can have beneficial downstream effects on attitudes toward people with higher weight, contributing scholarship to combat the pervasive societal problem of weight stigma.

RESEARCH DIRECTIONS

NHGRI supports research on genomic and environmental interactions (GxE), including the interactions of genes and diet and nutrition. NHGRI-funded investigators are elucidating complex interactions between genetics and environmental exposures to inform our understanding of the contributions of metabolism, diet, and eating behaviors to human health and disease.

Folate and vitamin B12 are essential nutrients for cell growth and neurological development, and deficiencies of these nutrients increase the risk of tumors, miscarriage, birth defects (including spina bifida), and cognitive problems in older people. NHGRI intramural investigators are studying genes that affect folate and vitamin B12 metabolism and contribute to disease. Detailed knowledge of the function of the genes in the folate/vitamin B12 metabolic pathways will add to our understanding of neural tube defects and potentially help guide public health policy in the area of nutritional supplementation. NHGRI intramural investigators are also conducting clinical and epidemiological research on patients with rare inborn errors of metabolism related to vitamin B12 metabolic pathways. They have created animal models to study these conditions and are continuing to develop novel gene therapies to treat these disorders.

NHGRI-supported researchers are also using comparative genomics to explore dietary adaptation in mammals to better understand human disease and inform therapeutic interventions for metabolic diseases, such as diabetes. One group is studying frugivorous mammals to glean insight into potential genetic factors underlying these animals' ability to consume large amounts of sugar via fruit without apparent disease consequences.

Obesity is a heritable health condition underpinned by a combination of genetic and environmental influences. NHGRI researchers are using virtual reality to teach individuals about the role of gene–environment interaction in eating behaviors and to examine whether education on this concept can have positive downstream effects on empathy and weight stigma. The scientists also studied the influence of a medical provider's apparent weight on potential patients' reactions to the weight-related genomic information she provides. The researchers also explored whether genetic beliefs about eating behaviors influenced dietary self-efficacy and confidence. The group is also using quantitative content analysis of social media to evaluate the information that the public encounters when considering nutrigenetics, which is defined as the science of the effect of genetic variation on dietary response.

Moreover, NHGRI-funded projects are studying the relationship between genetic variation and metabolism in humans, especially in a variety of diverse populations that are underrepresented in genomics research. A more robust understanding of how genetic variation affects the risk of obesity and metabolic disorders in diverse populations can lead to better methods of disease prevention and approaches to reducing health disparities. Hispanics are disparately impacted by nonalcoholic fatty liver disease (NAFLD), with the highest prevalence of the condition worldwide. One group of NHGRI-supported scientists is using a cell-based system to mimic dietary lipid overfeeding to better understand the factors influencing NAFLD risk. Another study is using samples from a large multiethnic cohort to study genetic and environmental contributions to obesity, type 2 diabetes, and other traits to create disease risk prediction models for ancestrally diverse populations. NHGRI also co-funds the Asian American Community Cohort and Equity Study (ACCESS), which seeks to understand why Asian Americans are at a higher risk for several cardiometabolic disorders and explore the variation in prevalence of cardiometabolic disorders across subgroups, in part by assessing dietary intake and other health behaviors in these populations.

Finally, NHGRI investigators and NHGRI-funded investigators are exploring how genetic and environmental factors contribute to complex diseases in Africans and African Americans. Co-led by FIC and NHGRI, NIH's Common Fund program Human Heredity and Health in Africa (H3Africa) has projects aimed at (1) building infrastructure and capacity to understand how genetic and environmental factors contribute to obesity and cardiometabolic disease in sub-Saharan Africa and (2) carrying out studies to identify these genetic factors. NHGRI intramural investigators are also focused on studying the contributions of genetics, environment, and such lifestyle factors as diet to cardiometabolic disorders in African populations. Working in concert with the H3Africa Consortium, NHGRI intramural investigators are performing analyses to identify genes and gene-pathways important to the pathophysiology of severe acute childhood malnutrition and modifiers of sickle cell disease in African populations. Intramural researchers also are conducting studies outside the H3Africa program to understand the genetic basis of diabetes, obesity, and heart disease in African diaspora populations, as well as other projects that seek to understand metabolic disorders and dyslipidemia in populations of African ancestry. NHGRI-supported investigators are also examining primary care physicians' attitudes and beliefs about genetic causes of obesity in Black and White patients to combat misguided notions of genetic differences between racial groups as the basis for obesity-related health disparities.

National Institute on Aging

https://www.nia.nih.gov

OVERVIEW

Since 1974, the National Institute on Aging (NIA) has led a broad scientific effort to understand the nature of aging and to extend the healthy, active years of life. In support of these aims, NIA is committed to the advancement of research on nutrition and its role in promoting healthy aging and preventing conditions associated with aging, as well as the development of nutritional interventions, both pharmacological and nonpharmacological. An enhanced understanding of the relationship between nutrition and healthy aging is more critical than ever, particularly given the projected growth of the age 65+ population in the United States, which is expected to comprise nearly a quarter of the population by 2060.

Research on nutrition and aging is supported by all four of NIA's extramural divisions—the Division of Aging Biology, Division of Behavioral and Social Research, Division of Geriatrics and Clinical Gerontology, and Division of Neuroscience. In addition, several laboratories within NIA's Intramural Research Program, notably the Translational Gerontology Branch, are conducting cutting-edge research to understand the fundamental mechanisms of aging and to develop nutritional interventions that support healthy aging. Specific efforts are detailed below.

KEY ACHIEVEMENTS

Select NIA-supported advancements in nutrition research are provided below:

- Findings from the NIA-supported COcoa Supplement and Multivitamin Outcomes Study of the Mind (COSMOS-Mind) trial suggest that a daily multivitamin may improve cognition in older adults. Investigators evaluated whether administration of a daily multivitamin or flavanol-containing daily cocoa extract supplement versus placebo across 3 years would improve cognitive performance. Results showed that those who took a daily multivitamin scored higher on tests of global cognition, memory, and executive function relative to the placebo. Cocoa extract had no effect on cognitive performance. These results suggest that a daily multivitamin may represent a safe, affordable, and accessible means of improving cognition among older adults.
- NIA-funded research has shown that the MIND (Mediterranean-DASH Intervention for Neurodegenerative Delay) and Mediterranean diets—both of which are rich in vegetables, fruits, whole grains, olive oil, beans, and fish—are associated with fewer signs of Alzheimer's disease in the brains of older adults. Specifically, participants with greater consumption of MIND and Mediterranean diet–based foods showed lesser accumulation of amyloid plaque, a hallmark of Alzheimer's disease. However, a recent NIA-funded clinical trial assigned 600 older adults with a family history of dementia to either a MIND-diet group or a control-diet group. Results showed that participants who followed the MIND diet had only small improvements in cognition that were similar to those who followed a control diet of mild caloric restriction. These results suggest that more research is needed to determine whether diet can help prevent or delay Alzheimer's disease and related dementias.
- The NIA-supported Comprehensive Assessment of Long-Term Effects of Reducing Intake of Energy (CALERIE) trial was the first clinical trial to examine the biological effects of 2 years of caloric restriction in humans. CALERIE not only demonstrated the feasibility of sustained caloric restriction but also revealed potential benefits for longevity and decreased risk for age-related conditions. Since these results were published in 2015, NIA has continued to fund research to elucidate the effects of caloric restriction on age-related health outcomes. In a 2022 publication, researchers examined data from the CALERIE trial to further evaluate the effect of a calorie-reduced diet in humans. Numerous benefits were identified, including improved immune function and decreased chronic inflammation, which may in turn translate to decreased risk for age-related diseases. Separately, another recent study found that calorie restriction combined with intermittent fasting elicits greater health benefits and longer lifespan in middle-aged female mice than intermittent fasting alone. The researchers explored the effects of a 20-percent caloric reduction combined with a type of intermittent fasting known as time-restricted feeding (TRF) in mice. Relative to a TRF-only diet, the diet combining caloric restriction and TRF increased lifespan and physical performance while decreasing frailty, tumor incidence, and the severity of inflammatory lung diseases.
- A recent NIA-funded research study using data from a multigenerational, community-based prospective cohort suggests that cholesterol and blood sugar levels in midlife may influence risk for Alzheimer's disease. This study uniquely evaluated the association between such risk factors in early midlife (ages 35–50) and Alzheimer's risk in later life. Investigators found that the

impact of glucose and cholesterol levels on Alzheimer's risk begins much earlier in life than previously thought, with lower high-density lipoprotein (HDL) cholesterol and higher triglyceride levels in early adulthood and high blood glucose levels in middle adulthood contributing to future risk of Alzheimer's disease. These findings support the idea that managing cholesterol and glucose levels at earlier points in adulthood may lower Alzheimer's risk.

- An NIA-supported study found that changes in the human gut microbiome may precede Alzheimer's disease–related cognitive decline. The microbiome (or the trillions of bacteria and other microbes that live in our bodies) differs in people with Alzheimer's disease compared with those with normal cognition. In this study, researchers saw that such microbiome differences arose even before the onset of Alzheimer's symptoms, when only preclinical brain biomarkers of Alzheimer's — such as amyloid-beta plaques and tau tangles — were detectable via brain scans. This work raises the intriguing possibility of microbiome-targeted treatments for Alzheimer's disease.

RESEARCH DIRECTIONS

NIA has and continues to fund a variety of studies on nutrition, each of which seeks to advance understanding of how nutrition influences the trajectories of health and aging. For example, NIA-funded studies have helped to elucidate the effects of diet–in terms of volume, timing, and content–on agingrelated health outcomes. Among these, the NIA-supported CALERIE trial was the first to examine the biological effects of 2 years of caloric restriction in humans. In other work, NIA is funding a clinical trial of time-restricted eating on weight loss and metabolism in adults ages 50–70 years who are overweight or affected by obesity. As evidenced by studies of the MIND and Mediterranean diets, as well as the COSMOS-Mind trial, NIA likewise supports investigations of dietary intake and supplementation to inform nutritional recommendations for healthy aging. In addition, the NIA-funded Alzheimer's Gut Microbiome Project is combining multiple nutritional trials, including the MIND trial, the Brain Energy for Amyloid Transformation in Alzheimer's Disease Study (BEAT-AD) trial of a modified Mediterranean-ketogenic diet, and the U.S. POINTER (Protect Brain Health Through Lifestyle Intervention to Reduce Risk) trial to understand how diet and the gut microbiome affect the brain.

NIA's priorities, ongoing research, and future directions on nutrition and aging—including the identification of research gaps and emerging topics—are informed by input from the research community, industry, and the public via NIA workshops and conferences. Topics of interest to the NIA extramural and intramural programs include the following:

- Effects of cellular and molecular mechanisms of age-related changes on nutrient sensing, metabolism, homeostasis, and differential cell function in preclinical model systems
- Interplay between circadian regulation and dietary interventions and its effects on circadian rhythm in older adults
- Effects of age on physiological processes through which nutrients, drugs, and other non-nutrient substances are absorbed, metabolized, and excreted in humans and preclinical animal models
- Basic and clinical studies of age-related changes in nutritional requirements and dietary needs
- Effects of nutrition on health disparities in older Americans and special subpopulations of older adults and the identification of nutritional risks in individuals who also have multiple chronic conditions
- Effects of interventions in humans as a result of different dietary patterns that influence the amount (i.e., caloric restriction), timing (e.g., intermittent fasting, time-restricted eating), macronutrient composition (e.g., high-carbohydrate, low-fat), or source (e.g., whole-food, plant-based) of food on the onset and treatment outcomes of age-related conditions
- Nutritional factors associated with physiological and psychological changes, such as immunocompetence, cardiovascular function, neurological function, body composition, physical function, sensory perception, control of appetite, macronutrient utilization, endocrine control, genetics, cognitive health, and emotional regulation in older adults
- Role of nutritional factors, including dietary supplements, in preventing and treating agerelated degenerative diseases, including diabetes, osteoporosis, neurological disorders, immune deficits, heart disease, cancer, gastrointestinal diseases, and other comorbidities

- Effects of neurological changes, such as those experienced in dementia, and declines in sensory reception and perception on nutrient intake
- Neural mechanisms underlying the control of eating, drinking, and satiety that affect nutrient intake in older adults
- Effects of diet, food extracts, and dietary supplements on cognition, sensory systems, and motor function in older adults
- General epidemiological studies and analysis of nutritional status and body composition and the correlation with cognition and other functional measures and contributions to health disparities
- Psychosocial aspects of nutrition, including studies of diet as a major factor contributing to cognition, quality of life, and other health outcomes (including how diet interacts with social, environmental, and lifestyle variables, such as food insecurity, food environment and availability, exercise, smoking, and consumption of alcoholic beverages among midlife and older adults)
- Behavioral aspects of dietary change, including behavioral economics and mechanistic studies of behavior change related to diet and other health behaviors in older adults

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

- Dietary Composition, Time-Restricted Feeding and Associated Metabolic Reprogramming in Healthspan and Longevity Regulation
- Methods and Measurement in Trials of 5-Year Caloric Restriction and Time-Restricted Eating Interventions
- Optimizing Dietary Amino Acid Intake to Improve Human Health and Reduce the Burden of Age-Related Disease
- Promoting Healthy Aging Through Nutrition

National Institute on Alcohol Abuse and Alcoholism

https://www.niaaa.nih.gov

OVERVIEW

The National Institute on Alcohol Abuse and Alcoholism (NIAAA) supports nutrition research through programs in basic and clinical sciences and seeks to identify the complex relationships between alcohol consumption, nutritional status, and health.

RESEARCH DIRECTIONS

Examples of nutrition research encouraged and supported by NIAAA include the following:

- Studies on alcohol metabolism and its effect on autonomic signals involved in alcohol and food intake
- Studies on alcohol's effects on the absorption, utilization, and excretion of minerals (iron, magnesium, zinc, selenium, and calcium) to clarify the role that alcohol-induced changes in these minerals may play in inducing pathological consequences of chronic alcohol consumption, such as liver fibrosis and hypertension
- Studies on ethanol's alteration of the distribution of essential fatty acids and prostanoid production and the role of eicosanoids in alcohol-induced physiological changes
- Studies on the role of alcohol-induced malnutrition in the pathogenesis of fetal alcohol syndrome (FAS), including impaired placental transport of nutrients
- Studies on the contribution of alcohol in modulation of the endocannabinoid system and appetite-regulating peptides, such as ghrelin and leptin
- Studies of the roles of thiamin deficiency, alcohol intake, and genetic predisposition in the etiology of cellular degeneration and Wernicke-Korsakoff syndrome
- Evaluation of the role of alcohol-associated increased iron accumulation in the development of alcoholic liver disease and pancreatitis
- Evaluation of the role of alcohol-associated depletion of folate, S-adenosylmethionine, and glutathione in the development of alcoholic liver disease, pancreatitis, cardiomyopathy, and lung injury
- Understanding the role of magnesium in alcohol-associated strokes
- Understanding the role of alcohol on fat metabolism (oxidation, synthesis, and transport of fatty acids) and its connection with the development of alcoholic liver disease and muscle wasting
- Studies on the possible role of fat and protein composition of the diet in management and prevention of fatty liver, alcoholic hepatitis, or liver fibrosis and cirrhosis
- Investigation of the effects of alcohol on vitamin A metabolism and associated tissue injury
- Examination of the role of choline, betaine, retinoids, and phosphatidylcholine in the attenuation of alcoholic liver disease
- Understanding the contribution of prenatal and postnatal nutritional factors that may modify risk for FAS in children with prenatal alcohol exposure
- Evaluation of nutritional deficits from alcohol-induced intestinal dysbiosis
- Understanding the interactions between alcohol misuse on the gut microbiome and microbial effects in the gut–brain axis
- Evaluation of the impact of alcohol use and misuse after bariatric surgery procedures, such as Rouxen-Y gastric bypass, sleeve gastrectomy, and laparoscopic adjustable gastric banding
- Studies on the impact of alcohol use and misuse on aging and age-related diseases, such as Alzheimer's disease

National Institute of Allergy and Infectious Diseases

https://www.niaid.nih.gov

OVERVIEW

Although the National Institute of Allergy and Infectious Diseases (NIAID) was established in 1948, its roots can be traced back to the Laboratory of Hygiene, a bacteriological laboratory founded in 1887 and the forerunner of NIH and NIAID. NIAID supports basic and clinical research in microbiology, infectious diseases, immunology, and allergy. A major component of NIAID's basic research concerns the fundamental life processes as exemplified in microorganisms and in animal cells *in vitro*. The techniques and basic biologic principles that were developed because of this fundamental research in microbiology and immunology have been applied to other areas of biology and medicine, including nutritional science.

Asthma and allergic diseases affect more than 60 million Americans. The complex interrelationships among nutrition, microbial infections, and immunology have significant health implications. In the developing world, more than 1.7 billion cases of infectious diarrheal disease occur annually in children under age 5. Malnutrition both predisposes children to diarrhea and occurs as a result of diarrhea. Poor nutrition compromises the immune system, and children who are malnourished are more vulnerable to life-threatening infectious diseases, as well as physical and cognitive impairments. Immunodeficiency conditions, such as HIV/AIDS, cause malnutrition and set the stage for coinfections and comorbidities that accelerate this cycle. Surgery and trauma lay the groundwork for infection and subsequent malnutrition. Many of these infections and conditions, or their complications, can be mitigated, at least in part, by appropriate nutrition.

NIAID studies on nutrition are integral to the institute's research to reduce the adverse health consequences of immunologic, allergic, and infectious diseases. Of particular significance are the consequences of wasting on the underlying HIV/AIDS disease process—including its infectious and immunological complications—and the role of nutrition in the development of safe and effective vaccines against infectious diseases. Ongoing concerns include the prevalence of infections among the malnourished; the effect of infections on nutritional status; host–microbiome interactions and their relationship to nutrition in health and disease; the prevalence and control of acute respiratory infections and foodborne microbial illness; and the effect of malnutrition on resistance to infection—especially to infectious diarrhea and respiratory diseases—in young children.

RESEARCH DIRECTIONS

NIAID's interest in nutrition aims to better understand the complex interrelationships of nutrition, immunity, and infection to expand the knowledge that can be applied to developing improved diagnostics and strategies for the prevention and treatment of inflammation and infection. The institute's research directions are correspondingly varied. They include the following:

All aspects of nutrition and the prevention, development, consequences, and treatment of HIV/AIDS; the relationship of nutrition to the development and treatment of comorbidities (such as osteopenia and dyslipidemia) associated with HIV disease and treatment (NCT02344290; PMID: DOI:10.1056 NEJM); the relationship of nutrition to the pathogenesis and treatment of pediatric HIV disease, such as growth and development, including the impact of infant feeding choices; and the impact of undernutrition on absorption and pharmacodynamics of antiretroviral agents (PMID: 37919816; PMID: 38808862; NCT01818258)

- The impact of malnutrition on the development of environmental enteric dysfunction, childhood stunting, and resistance to enteric infections
- The role of host–microbiota interactions and their relationship to nutrition in determining the optimal outcome of vaccines, immunotherapies, and organ transplantation
- Understanding the impact of breast milk and early-life nutrition on neonatal immunity and mechanisms of vaccine-induced protection from infection
- The impact of micronutrient deficiencies on the outcome of acute respiratory infections and viral evolution and the role of vitamin D, vitamin B6, and other micronutrients on tuberculosis and other infectious diseases
- The role of nutrition and dietary intake in controlling the immune response to animal parasites that cause significant human disease (e.g., schistosomiasis, giardiasis, cryptosporidiosis)

- Dietary regulation of immunity and inflammation in the gut and how microbiota-derived metabolites regulate host immunity and inflammation
- The modulating effects of specific nutrients (e.g., vitamins, trace elements, fatty acids, fiber, amino acids) and probiotics/prebiotics on inflammatory pathways and immune function
- The natural history and genetics of food allergy (NCT02504853) and the relationships between early-life diet, the gut microbiome and metabolome, and the development of food allergies and other atopic diseases in childhood (NCT04798079)
- Early introduction of allergenic foods to prevent the development of food allergy (NCT03546413; PMID: 38804779)
- Development and clinical testing of immunomodulatory interventions to prevent and treat food allergies (NCT03679676, NCT03881696; PMID: 38407394)
- Research to test the impact of dietary and symbiotic strategy on colonization resistance to *Clostridioides difficile* and microbiome composition in oncology patients (NCT04940468) and the effect of probiotic for pathogen-specific *Staphylococcus aureus* decolonization (PMID:36646104; TCTR20210128003)
- Treating atopic dermatitis to reduce the incidence of food allergen sensitization under the hypothesis that, in infancy, inflamed skin may promote the development of food allergy (NCT03742414)

National Institute of Arthritis and Musculoskeletal and Skin Diseases

https://www.niams.nih.gov

OVERVIEW

The National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) conducts and supports basic and clinical research on many of the most debilitating diseases affecting the U.S. population. These include the many forms of arthritis and numerous diseases of the musculoskeletal system and skin, as well as research on the normal structure and function of joints, muscles, bones, and skin. NIAMS is the lead institute at NIH for research on osteoporosis and related bone diseases. Basic research involves a wide variety of scientific disciplines, including immunology, genetics, molecular biology, biochemistry, physiology, virology, and pharmacology. Clinical research addresses the fields of rheumatology, orthopedics, bone endocrinology, sports medicine, and dermatology.

RESEARCH DIRECTIONS

NIAMS supports programs of research and research training in the fields of arthritis, musculoskeletal diseases, bone biology and bone diseases, muscle biology, and skin diseases. The institute has an interest in the role of nutrition in disease etiology, primary and secondary prevention of disease, improvement of physical function, and promotion of quality of life among populations with or at risk for NIAMS core mission diseases (arthritis, musculoskeletal, and skin disorders). Examples of ongoing nutrition research supported by NIAMS include the following:

- Studies on the function of diets and nutrients in osteoarthritis; muscle growth and repair; skin repair; and such autoimmune diseases as juvenile arthritis and lupus, inflammation, and joint pain
- Development of a community weight-loss program that could be scaled to improve quality of life and mobility and reduce osteoarthritis knee pain in urban and rural communities
- The role of lipolysis in regulating bone formation and repair
- Investigation of dietary risk factors for bone loss and dietary intervention to prevent bone fractures
- The impact of dietary supplements in reversing obesity-related osteoarthritis and other systemic inflammation
- Research on how obesity-related muscle loading contributes to inflammation, cartilage loss, and changes in joint morphology
- The role that vitamin D supplementation plays in improved oxidative metabolism and decreased atrophy, driving repair in normal and injured muscle tissue
- The translation of unique micronutrient deficiencies seen in patients with different subtypes of systemic juvenile idiopathic arthritis into the development of a urine-based biomarker assay that can be used to personalize and improve their response to treatment

Eunice Kennedy Shriver National Institute of Child Health and Human Development

https://www.nichd.nih.gov

OVERVIEW

The mission of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD) is to lead research and training to understand human development, improve reproductive health, enhance the lives of children and adolescents, and optimize abilities for all. Because nutrition is so critical to growth and development, nutrition research is a major focus in many of NICHD's key research areas, including developmental biology, reproductive sciences, maternal health, pregnancy and perinatology, pediatrics, and therapeutics. For this reason, nutrition is one of five crosscutting themes for the NICHD strategic plan.

KEY ACHIEVEMENTS

NICHD-supported researchers have advanced nutrition science across a broad spectrum of topics. Below are a few examples of key NICHD-supported research findings in nutrition.

- **Nutritional Factors Associated with Preterm Birth and Length of Gestation:** In 2022, NICHD-funded scientists reported that women taking 1,000 mg of docosahexaenoic acid (DHA) daily in the last half of pregnancy had a lower rate of early preterm birth than women who took the standard 200 mg dose. Women who entered the study with the lowest DHA level had the greatest reduction in early preterm birth. Since then, a more detailed analysis of the data from this study has strengthened the study results. Specifically, in a subsequent statistical analysis of the data from this study, researchers showed that total vitamin A intake among pregnant women was associated with longer gestation, while intake of fructose and arachidonic acid—a long-chain omega-6 fatty acid—was associated with shorter gestation. These results indicate that nutrition may play a significant role in preterm birth risk.
- **Fortified Human Milk May Promote Growth of Preterm Infants:** In a randomized clinical trial, researchers found that extremely preterm infants fed fortified human milk grew longer and more rapidly and had larger head circumferences than infants fed unfortified human milk. These results are especially important in caring for these particularly vulnerable infants, who are at serious risk for malnutrition, poor growth, and a variety of serious complications.
- **Urea in Breast Milk Feeds Beneficial Bacteria in Infant Gut:** Microorganisms comprising the microbiome in the infant digestive track help tissue mature, participate in essential biochemical reactions, and foster the development of the immune system. NICHD-supported researchers found that urea, present in breast milk but not digested by the infant, appears to foster the growth of beneficial bacteria in the infant gut.
- **Preconception Weight Loss and Gestational Diabetes Risk:** Gestational diabetes affects 8 percent of pregnant individuals in the United States and increases the risk of pregnancy complications and cardiometabolic disease. Because overweight and obesity are risk factors for developing gestational diabetes, researchers designed a diet and exercise plan promoting weight loss for women with previous gestational diabetes who are planning to conceive again. Although the intervention was effective in promoting preconception weight loss, there was no evidence that it reduced the risk of gestational diabetes recurrence.
- **Nationwide Programs for Reducing Food Insecurity Were Not Associated with Childhood Obesity:** The Supplemental Nutrition Assistance Program (SNAP), the Free/Reduced Priced Lunch Program (FRPL), and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) are the largest nationwide programs for reducing food insecurity among low-income infants and children. Concerns have been raised that these programs are associated with an increase in obesity. Researchers computed child BMI z-scores, a measure of relative weight adjusted for age and sex, for children who participated in one or more of these programs and for children from similarly low-income families who did not participate. They found no associations between participation in SNAP, FRPL, or WIC and increased child obesity at the end of fifth grade.

RESEARCH DIRECTIONS

Nutrition is critical to growth and development. New technologies and methods allow scientists to characterize the complex biology of nutrition and the effects of nutritional status on health using a more systems-based approach. The recent revolution in omics technologies, including metabolomics, and discoveries related to the interplay among diet, nutritional status, and the microbiome create important scientific opportunities. These new avenues for scientific discovery will allow NICHD to understand the lifetime impact of nutrition on reproductive health; fertility; pregnancy; and fetal, child, and adolescent growth and development. Of unique interest to the institute is a better understanding of the composition and function of human milk, the effect of maternal nutrition and length of gestation on human milk composition and lactation, and the optimal source of nutrition and mode of nutrient delivery to the infant, especially preterm infants. Within the institute's extramural research portfolio, the Pediatric Growth and Nutrition Branch supports extensive research in pediatric endocrinology and nutrition and their impact on health promotion and disease prevention throughout the life course. In the intramural program, biomedical studies in the Division of Intramural Research and biobehavioral studies in the Division of Population Health Research are focused on advancing knowledge of nutrition and the microbiome, micronutrients, and behavioral factors contributing to eating behaviors. Because it was clear that the institute's success in advancing its scientific goals and objectives will depend on its ability to integrate nutrition into research across the scientific research portfolio, nutrition was selected as one of five crosscutting themes for the NICHD strategic plan.

NUTRITION TRAINING

Training in Maternal and Child Nutrition (T32HD087137**):** This program supports the development of new researchers to address the compelling need to understand not only how to prevent nutritional problems in women of childbearing age and young children, but also how to mitigate the effects of these problems on later health.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

- Biomarkers of Nutrition for Development–Knowledge Indicating Dietary Sufficiency (BOND-KIDS) Working Group Meetings
- Bridging the Biological and Communication Sciences on Nutrients and Environmental Contaminants in Foods to Support Child Development
- ADVANTAGE (Agriculture and Diet: Value Added for Nutrition, Translation, and Adaptation in a Global Ecology) Project Virtual Meeting Series
- Socio-Ecological Factors and the Double Burden of Malnutrition (DBM) Among Children and Adolescents in Low- and Middle-Income Countries (LMICs)
- Climate Change and Health Seminar Series: The Double Burden of Heat Stress and Maternal Malnutrition on Newborn Vulnerability

TOOLS AND RESOURCES

- Fetal Growth Calculator
- Pregnancy for Every Body
- Data on many previous NICHD studies, including groundbreaking studies of bone mineral density and other nutrition-related topics, are available at the Data and Specimen Hub (DASH).

National Institute on Deafness and Other Communication Disorders

https://www.nidcd.nih.gov

OVERVIEW

The National Institute on Deafness and Other Communication Disorders (NIDCD) conducts and supports research and research training on normal mechanisms, as well as on diseases and disorders, of hearing, balance, taste, smell, voice, speech, and language.

KEY ACHIEVEMENTS

Food choice has a profound impact on our overall health. NIDCD is supporting research to understand how what we taste changes our brain to influence adult food choices and to achieve progress in enhancing nutrition. The gustatory cortex (GC) in the brain specializes in taste-related functions, such as anticipating taste and identifying safe and spoiled foods. Using a mouse model, NIDCD-supported researchers found evidence that neural circuits in the GC change based on early taste experience, thus establishing sweet preference. They identified a critical period during early life when sweet preference is established and described how early taste experiences influence GC circuits to maintain this preference in adult mice. These findings highlight the importance of early taste experiences, both for adult taste preferences and for establishing normal taste circuitry in the developing GC.

NIDCD has also advanced health care in the NIDCD smell (olfaction) mission area. Olfactory disorders negatively impact quality of life. Loss of smell affects up to 30–80 percent of people who get COVID-19, depending on the variant of SARS-CoV-2 viral infection. Tests have been developed that measure total (anosmia) or partial (hyposmia) loss of smell. However, these tests are difficult and costly to carry out on a widespread scale during a pandemic. To make screening for olfactory disorders more affordable and accessible, NIDCD has supported investigators to develop rapid, inexpensive, and self-administered smell tests that can detect and discriminate between different types of olfactory disorders. These new tests provide an option for population-wide surveillance of smell function in a wide range of settings, including during a pandemic. Similarly, these smell tests may also be used to detect early signs of other serious health conditions, like Parkinson's disease, where hyposmia is a frequent symptom, so that patients can receive early treatment. These examples highlight how NIDCD supports applied research, experimental development, pre-commercialization, and standards-related efforts that will facilitate the adoption of a broad range of new technologies.

NIDCD recently hired a new clinical director. The clinical director oversees NIDCD's clinical and translational research program conducted in the NIH Clinical Center, a world-class research hospital located on the NIH campus in Bethesda, Maryland. NIDCD's clinical program fosters interaction to support preclinical, translational, and clinical studies aimed at developing novel diagnostic and therapeutic strategies for disorders affecting hearing, balance, taste, smell, voice, speech, and language. The clinical director will also head NIDCD's new Sinonasal and Olfaction Program, in which a multidisciplinary team will explore basic science discoveries that have the potential to advance taste and smell treatments for patients.

RESEARCH DIRECTIONS

The NIDCD Taste and Smell Program supports studies of the chemical senses known as taste, smell, and chemesthesis (chemically provoked irritation) to enhance our understanding of how individuals gather information about their environment and how human chemosensory disorders can be diagnosed and treated. NIDCD-supported research on molecular and cellular biology, animal models, biophysics, and biochemistry of the olfactory and gustatory systems is paving the way for improved diagnosis, prevention, and treatment of chemosensory disorders.

National Institute of Dental and Craniofacial Research

https://www.nidcr.nih.gov

OVERVIEW

The mission of the National Institute of Dental and Craniofacial Research (NIDCR) is to improve dental, oral, and craniofacial health through research and research training, and by promoting the timely transfer of knowledge gained from research to the public. NIDCR supports a diverse portfolio of dental, oral, and craniofacial research related to taste, smell, diet, nutrition, diabetes, and obesity, including research on head and neck cancer, cleft lip and palate, tooth decay, and gum disease and the impact of dental, oral, and craniofacial diseases on diet and nutrition intake. NIDCR supports research to better understand the mechanisms underlying the relationship between nutrition; overall health; and dental, oral, and craniofacial health. This understanding is essential to designing effective strategies and interventions to improve oral health, nutritional status, and comprehensive health over the lifespan.

KEY ACHIEVEMENTS

Designing Health Promotion Messages to Help Reduce Dietary Sugar

An NIDCR-funded study developed an intervention to reduce consumption of sugar-sweetened beverages and food among adults residing in public housing developments, a population with high rates of chronic disease. The intervention included a series of picture-based health promotion messages that were developed with input from members in the community. The researchers found high overall acceptability of messages delivered via print, text, or social media; however, messages targeting motivation were found to be less acceptable. These findings suggest that engaging members of the community worked well to develop messages designed to reduce sugar-sweetened beverage and food consumption and that multiple communication channels should be considered.

Athletes Drink Gatorade: Advertising Expenditures, Ad Recall, and Athletic Identity Influence Energy and Sports Drink Consumption

One NIDCR-funded study aimed to understand why sports and energy drinks, which contain added sugars, remain increasingly popular among adolescents despite declines in consumption of other sugar-sweetened beverages. The researchers collected self-reported data on exposure to television advertisements for sports drinks, frequency of consuming sports drinks, and how strongly the individual considered themselves to be an athlete (e.g., athletic identity) from more than 500 U.S. adolescents. This information was then combined with television and social media advertising expenditures. The researchers found that adolescents' recall of advertisements was related to their consumption of sports drinks but not to the television advertising expenditures where they lived. The researchers also found that consumption of sports drinks increased when both self-reported recall of advertising and athletic identity increased. This study suggests that the effectiveness of advertising expenditures in influencing behavior is dependent upon both recall and relevance of the advertisement and that athletic identity is an important factor in the effectiveness of sports and energy drink advertising.

RESEARCH DIRECTIONS

Nutrition and Oral and Overall Health

NIDCR supports and encourages research on nutrition and oral and overall health. In FY 2023, NIDCR developed an initiative to determine the tri-directional relationship between oral health, nutrition, and comprehensive health. The purpose of this initiative is (1) to support research to better understand the mechanisms of the tri-directional relationship between nutrition, systemic health, and oral, dental, and craniofacial health and (2) to develop interventions for the dental setting. Knowledge gained could help identify preventive diagnostic and therapeutic interventions to improve oral health, nutritional status/food insecurity, and comprehensive health across the lifespan.

NIDCR also supports nutrition-related research in the following areas:

- Changes in diet and behavior to reduce sugar consumption and its impact on tooth decay in early childhood (U01DE028508)
- Role of Vitamin D in the expression of immunity genes and inflammation (R01DE028883)

- Role of natural medicinal compounds (e.g., extracts from turmeric or aloe vera) to improve bone healing (R01DE029204)
- Effects of fatty acids on food and pain mechanisms in disorders of the jaw joint (R34DE033563)
- Development of novel probiotics for the treatment of salivary gland disorders, such as Sjögren's disease and for prevention and control of tooth decay and gum disease (SB1DE030833)
- Role of the tissue lining the mouth in infections caused by viruses and imbalances in taste (R56DE031751)
- Role of the mother's social environment in supporting healthy behaviors to prevent tooth decay and nutrition-related diseases in children (UG3DE032003)
- Developing systematic messages to reduce the consumption of sugary food and drinks among adult residents of public housing (R01DE027985)
- Impact of weight-loss surgery to resolve diabetes on the microbial community in the mouth (R01DE026603)
- Role of maternal folic acid injections during pregnancy in reducing cleft palate occurrences in infants (R21DE032742)
  - Oral Microbiome
- Role of the consumption of processed grain on the oral microbiome and gum disease (F30DE031182)
- Role of the microbiome–host relationship during wound healing in the mouth (R21DE030632)
  - Diabetes, Metabolic Syndrome, and Oral Health
- Mechanistic pathways of diet-induced obesity that affect susceptibility to gum disease and its progression (R56DE024796)
- Role of metabolic syndrome on the oral microbiome and gum inflammation (R03DE030527)
  - Nutrition and Oral Cancer
- Use of vitamin D3 as a dietary supplement to improve the efficacy of oral cancer treatment (R56DE032268)
- The efficacy of bitter melon extract and its active component on preventing and treating head and neck cancer (R01DE025141)

NUTRITION TRAINING

- NIDCR supports several nutrition research training awards, including the following examples:
- The effect of a high fatty acid diet on nerve pain in the mouth and face (F30DE031177)
- The role of folate, an essential nutrient, in modifying the harmfulness of gum disease-causing bacteria (F32DE031493)
- Modifying signals between the gut and brain to treat increased sensitivity to pain and tolerance caused by opioids (F31DE029686)

National Institute of Diabetes and Digestive and Kidney Diseases

https://www.niddk.nih.gov

OVERVIEW

The mission of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) is to conduct and support medical research and research training and to disseminate science-based information on diabetes and other endocrine and metabolic diseases; digestive diseases, nutritional disorders, and obesity; and kidney, urologic, and hematologic diseases, to improve people's quality of life. NIDDK's research responsibilities have involved nutrition-related research and research training to prevent and treat multiple diseases and disorders, including liver and biliary diseases; pancreatic diseases; gastrointestinal, digestion, and absorption disorders; diabetes; obesity; a variety of endocrine disorders; kidney and urological diseases; metabolic diseases, including cystic fibrosis; eating disorders; and nutrition-related health disparities and social risk factors, such as food insecurity and nutrition insecurity. This research is supported by three divisions: the Division of Diabetes, Endocrinology, and Metabolic Diseases (DEM); the Division of Digestive Diseases and Nutrition (DDN); and the Division of Kidney, Urologic, and Hematologic Diseases (KUH). NIDDK's Office of Obesity Research (OOR) helps coordinate obesity research across the divisions and across NIH, and its Office of Minority Health Research Coordination (OMHRC) collaborates with other NIH institutes, centers, and offices to develop plans and funding opportunities that address the burden of diseases and disorders that disproportionately impact minority populations, including nutrition-related disorders and diseases. NIDDK released its 5-year NIDDK Strategic Plan for Research in 2021 and a report from its Advisory Council Working Group on *Pathways to Health for All: Health Disparities and Health Equity Research Recommendations and Opportunities* in 2023.

KEY ACHIEVEMENTS

NIDDK supported advances in nutrition research in fiscal years 2022–2023 (FY22–FY23), such as the following:

- Studies supported by NIDDK provided evidence that time-restricted eating during active periods may be an effective alternative to traditional dieting for individuals needing to lose weight to manage health risks. For example, a clinical trial found that people with obesity and type 2 diabetes lost more weight over 6 months using daily periods of intermittent fasting than by restricting calories. Similarly, a study in firefighters on 24-hour schedules found that time-restricted eating was feasible in this group of shift workers and led to cardiometabolic benefits, particularly for those with health risks at the start of the study. Research in mice revealed that changes in fat metabolism may be a reason late-night eating is linked to weight gain and metabolic disease.
- Research on the complex interplay of diet and the gut microbiome could lead to more personalized approaches to nutrition. In a controlled feeding study in people, researchers found that a diet designed to nourish the gut microbiome led to altered microbial composition, diversity, and function; changes in people's hormones; and improved energy balance.
- Researchers discovered how gut sensory cells discern nutritive sugars from noncaloric artificial sweeteners to guide an animal's preference for sugar. Research also provided initial evidence that sugar-sweetened beverage taxes implemented in five U.S. cities could lead to better health outcomes for pregnant women and their children. These results provide evidence that limiting sugar intake through such approaches as taxes on sugary beverages may be effective for improving health.
- A study on the effects of discrimination—based on race, sex, disability, sexual orientation, or other factors—showed that people who reported high levels of discrimination had both increased brain activity and neuroactive molecules in the gut when seeing unhealthy foods. These findings suggest that discrimination may trigger unhealthy crosstalk between the gut and brain, contributing to inflammation, obesity, and other health issues.

RESEARCH DIRECTIONS

NIDDK fosters and supports nutrition research and training in multiple areas of basic, epidemiological, and clinical nutrition, as well as nutrition health disparities. The majority of this research is investigator-initiated. Selected topics from the NIDDK nutrition research portfolio in FY22–FY23 include the following:

- Research projects supported in response to funding opportunities focused on

(1) developing tools and devices to continuously monitor nutrients, metabolites and/or metabolic signals for advancing precision nutrition, microbiome, and circadian metabolism research

(2) supporting the development of swallowable tools and devices for sampling or monitoring interactions among diet, gastrointestinal tissue, and microbes

(3) developing biomarkers of dietary intake and exposure

(4) identifying and characterizing bioactive microbial metabolites' effects on host health and disease

(5) promoting research on food-specific molecular signatures and biomarkers of dietary consumption

(6) addressing how food insecurity affects HIV comorbidities, coinfections, and complications

(7) notifying applicants of an area of special interest in understanding factors in infancy and early childhood that influence the development of obesity

(8) characterizing early-life risk factors and elucidating underlying mechanisms through which these risk factors contribute to the development of obesity during infancy and early childhood

(9) understanding what happens to a mother's metabolism during pregnancy, specifically when developing gestational diabetes, including nutrition-related measures

(10) supporting time-sensitive research to evaluate a new policy or program that is likely to influence behaviors (e.g., dietary intake, physical activity, sedentary behavior, and/or sleep) and/or weight outcomes in an effort to prevent or reduce obesity

» One example of a significant nutrition research program supported by NIDDK is the Physiology of the Weight Reduced State Clinical Trial Consortium, or POWERS. This consortium aims to better characterize risk factors and understand the underlying mechanisms through which these factors contribute to the development of obesity during early childhood. The goal is to develop innovative, targeted, and more effective strategies for childhood obesity prevention.

» NIDDK also supports the national research effort on nutrition and obesity through its Nutrition Obesity Research Centers, Diabetes Research Centers, and Digestive Diseases Research Core Centers programs.

NUTRITION TRAINING

NIDDK supported nutrition research training in FY22 and FY23 through such efforts as the Bringing Resources to Increase Diversity, Growth, Equity, and Scholarship for Obesity, Nutrition, and Diabetes Research (BRIDGES) Consortium. The purpose of this consortium is to enhance the diversity of the research workforce that is available to successfully compete for independent research funding from NIH in the areas of nutrition, obesity, diabetes, and related conditions. This program will establish a consortium providing professional development, mentoring, networking, pilot and feasibility funds, and other opportunities designed to advance the career development of postdoctoral scholars and early career faculty from diverse backgrounds who intend to pursue a research career focused on nutrition, obesity, diabetes, and/or related conditions. The program will be administered through research institutions with substantial existing NIH funding within the research mission of NIDDK. NIDDK supported BRIDGES programs at four sites throughout FY22 and FY23.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

Examples of nutrition workshops and symposia that NIDDK sponsored in FY22 and FY23 include the following:

» Workshop on Housing and Obesity: Gaps, Opportunities, and Future Directions for Advancing Health Equity

» Neural Plasticity in Energy Homeostasis and Obesity workshop

» NIH Obesity Research Task Force Symposium: Medications to Treat Obesity: Past, Present, and Future

» Pharmacotherapy for Obesity in Children and Adolescents: State of the Science, Research Gaps, and Opportunities workshop

TOOLS AND RESOURCES

NIDDK provided the following resources in support of nutrition research during FY22 and FY23:

- Nutrition Obesity Research Centers
- Digestive Diseases Research Core Centers
- Diabetes Research Centers
- National Centers for Metabolic Phenotyping in Live Models of Obesity and Diabetes
- Research Training & Career Development
- NIDDK Central Repository

National Institute on Drug Abuse

https://nida.nih.gov

OVERVIEW

The mission of the National Institute on Drug Abuse (NIDA) is to advance science on drug use and addiction and to apply that knowledge to improve individual and public health.

KEY ACHIEVEMENTS

National Institute on Drug Abuse (NIDA) ABCD Study and HBCD Study

The NIDA-led NIH-wide Adolescent Brain Cognitive Development (ABCD) Study is the largest long-term study of brain development and child/adolescent health ever conducted in the United States. Following nearly 12,000 children, this study uses neuroimaging and cognitive, biospecimen, environmental, and survey data to help us understand how adolescence shapes brain, cognitive, and social development. Funded by the NIH Helping to End Addiction Long-term® Initiative (NIH HEAL Initiative®), in collaboration with NIDA and other NIH institutes, centers, and offices, the HEALthy Brain and Child Development (HBCD) Study will recruit more than 7,000 pregnant participants at 27 recruitment sites across the United States. The study will collect information during pregnancy, at birth, and across the first decade of life to better understand how child development is affected by nutrition and its association with biological, social, and environmental experiences and conditions.

Collectively, the ABCD and HBCD Studies are gathering data related to nutrition to understand the mechanisms underlying the association of *in utero* exposure to gestational diabetes mellitus, the association between breastfeeding duration and cognitive performance in elementary school children, the factors associated with the development of eating disorders in adolescence, and more. To encourage secondary analysis of ABCD data, the study releases to the scientific community de-identified fast-track neuroimaging data on an ongoing basis and full data once per year. The first HBCD data release is planned for late 2024. Additionally, HBCD is collecting biospecimen samples from birth parents and children. The samples will be stored in a biobank for future analyses, including on prenatal and early-life nutrition, as funds become available.

RESEARCH DIRECTIONS

NIDA encourages and supports an extensive portfolio of research at the intersection of nutrition and substance use in human and animal subjects. Examples of NIDA-funded research and areas of interest include:

- Studies of the addiction-like effects of highly palatable foods and, conversely, the role of appetite-regulating peptides—such as orexin/hypocretin, leptin, ghrelin, insulin, and GLP-1—as potential targets for treating substance use disorders
- Assessing the biological basis for comorbidity of eating and substance use disorders, including the role of stress hormones and specific neurotransmitter systems
- Identifying biobehavioral mechanisms underlying appetite changes associated with smoking cessation, including the role of genetic factors and gender differences
- Neurobiological and behavioral studies of brain reward systems and underlying mechanisms of drug and food seeking to help characterize processes of dysregulated appetite
- Whether, and through what mechanisms, nutritional conditions affecting homeostatic regulation, food restriction, or specific nutrients alter drug taking and relapse to drug taking
- Understanding through what mechanisms prenatal drug exposure modifies subsequent vulnerability for feeding difficulty and hyperphagia
- Assessing culturally adapted behavioral prevention interventions that promote physical activity and nutrition

National Institute of Environmental Health Sciences

https://www.niehs.nih.gov

OVERVIEW

The mission of the National Institute of Environmental Health Sciences (NIEHS) is to discover how the environment affects people in order to promote healthier lives. Our research is aimed at discovering and explaining how a variety of factors, such as chemical, physical, synthetic, and infectious agents; social stressors; medications; our own microbiomes; and diet, affect biological systems.

Nearly 1 in 5 people include botanical dietary supplements in their nutrition regimen; however, botanical ingredients often do not have adequate safety data available. Ongoing research within the NIEHS Division of Translational Toxicology aims to generate information that will be useful to consumers, medical professionals, and regulatory authorities regarding botanical ingredient safety.

KEY ACHIEVEMENTS

In experimental toxicity studies of black cohosh, a dietary supplement used to support gynecological health, long-term oral exposure led to increases in micronucleus induction in female mice and some nonneoplastic lesions in the uterus and ovary of female rats. This work addresses an important gap in our understanding of the biological effects of black cohosh, thereby enabling more informed decisions about the safe use of this widely used dietary supplement.

Recommendations for analyzing complex botanical mixture chemistry and selecting an appropriate test article were provided using the example of black cohosh. This work provides a framework for other researchers in the field to ensure that tested substances are authentic, thereby increasing confidence in the data that are generated in studies to evaluate safety.

A survey of the dietary supplement ingredients blue cohosh, yohimbe, and goldenseal was conducted to look for chemical variability in products on the marketplace. Instances of adulteration and variable concentrations of marker compounds were found, indicating that consumers should proceed with caution when purchasing dietary supplements from online sources.

RESEARCH DIRECTIONS

NIEHS plays a lead role in the Botanical Safety Consortium, a public–private partnership aimed at evaluating the suitability of new approach methodologies for use in assessing complex botanical mixtures. A framework of recommended assays and approaches will help industry partners and regulators interpret data from these assays and evaluate the safety of complex botanical mixtures.

α-Pinene, a flavor ingredient, was found to metabolize into a mutagenic metabolite, α-pinene oxide, in both human and rodent hepatocytes. Research into the toxicokinetics of α-pinene following oral intake and the presence of α-pinene in pine bark extract dietary supplements is ongoing.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

The annual Botanical Safety Consortium Summit in October 2024, sponsored by NIEHS, the FDA, and the Health and Environmental Sciences Institute, will bring together diverse multidisciplinary stakeholders from industry, academia, and government to provide updates on research progress in evaluating new approach methodologies for assessing the safety of complex botanical mixtures.

TOOLS AND RESOURCES

All data generated by Botanical Safety Consortium projects will be hosted in the NIEHS Chemical Effects in Biological Systems database. This publicly available resource will provide researchers with the opportunity to further develop tools and approaches for analyzing chemical and biological response data from complex botanical mixtures.

National Institute of General Medical Sciences

https://www.nigms.nih.gov

OVERVIEW

The National Institute of General Medical Sciences (NIGMS) supports basic research that increases our understanding of biological processes and lays the foundation for advances in disease diagnosis, treatment, and prevention. NIGMS also supports research in specific clinical areas that affect multiple organ systems: anesthesiology and peri-operative pain; clinical pharmacology common to multiple drugs and treatments; and injury, critical illness, sepsis, and wound healing. NIGMS-funded scientists investigate how living systems work at a range of levels—from molecules and cells to tissues and organs—in research organisms, humans, and populations. Additionally, to ensure the vitality and continued productivity of the research enterprise, NIGMS provides leadership in supporting the training of the next generation of scientists, enhancing the diversity of the scientific workforce, and developing research capacity across the country.

In accordance with its mission, NIGMS investments in nutrition research advance the fundamental understanding of biological processes as they relate to how living things synthesize, absorb, and process nutrients. NIGMS supports fundamental research on the basic biochemistry of physiological processes in cells and bacteria, including the mechanisms that underlie human metabolism. NIGMS also supports studies that seek to understand the physiology of microorganisms in the gut and how they interact with host biology. As part of the research capacity-building element of its mission, NIGMS supports programs that enable institutions in states that historically have received low levels of NIH funding to perform competitive, cutting-edge research. Nutrition research is one area of interest for researchers in these states, especially given the disproportionally high burden of chronic diseases having a nutritional component (e.g., obesity, diabetes, cardiovascular disease). NIGMS also funds Pre-K–12 science education research related to educating students about nutrition science.

KEY ACHIEVEMENTS

» The multidisciplinary Center for Childhood Obesity Prevention (CCOP) at the Arkansas Children's Hospital Research Institute, funded by the Centers of Biomedical Research Excellence (COBRE) program, established a comprehensive pediatric obesity research program centered on disease prevention that supports research on complex disease origins, epidemiology, and social systems to address the childhood obesity crisis. The capacity built by the COBRE award has helped to grow the research community, ultimately producing more than 20 articles published between 2023 and 2024. Of particular relevance, a 2023 publication explored the association between food insecurity and obesity among Native Hawaiian and Pacific Islander adolescents.

» Understanding human milk oligosaccharides (HMOs), the unique sugars found in human milk, can provide insights into how these sugars influence human health and healthy infant development and contribute to the discovery of novel antimicrobial, anti-inflammatory and anti-cancer agents. NIGMS supports basic research on the chemical processes of HMOs and on developing better methods to chemically synthesize them for enabling future research and improving neonatal health. NIGMS-supported researchers discovered a successful strategy for performing the chemical synthesis of two common core HMOs, thereby advancing studies in understanding the roles of these biomolecules for future efforts to accelerate access to HMOs for neonatal health and biomedical applications.

RESEARCH DIRECTIONS

As part of NIH, NIGMS invests in basic research on nutrition and gut microbiome and capacity building to further support biomedical research in those areas.

Supporting Basic Research

» **Foundational Metabolic Studies:** NIGMS supports fundamental research on the basic biochemistry of physiological processes in cells and bacteria, including mechanisms underlying metabolism in the gut. Examples include the following:

- Developing protein-based fluorescent sensors to uncover molecular mechanisms through which metal ions affect gut microbiota balance. Earlier fundamental studies have shown that gastric acids produced in the gut interact with

nitrate-rich foods—such as green, leafy vegetables—to create nitrated fatty acids that exert protective and anti-inflammatory properties.

- Studying the mechanism of formation and signaling actions of a fatty acid called linolenic acid, which could open the door to dietary approaches to metabolic and inflammatory diseases.
- Using genetic and biochemical approaches to tackle two nutrient-related mechanisms involved in human health: the beneficial actions of metabolites (substances produced during metabolic processes, such as digestion) and discovery of a gut-initiated pathway that senses imbalances in the metabolism of nucleotides, which are the building blocks of RNA and DNA

» **Gut Microbiome:** Cataloging the microbiota of the gut and delineating how this network of microorganisms interacts with the gut, nutrient uptake, and immune function is an area of active support at NIGMS. Examples include the following:

- Combining bacteriology, microfluidics, and imaging expertise to develop genetic tools that can be applied to analyze the entire microbiome at once, making it easier to understand how microbial genes affect human health.
- Studying a class of lipids known as *sphingolipids* that act as signaling and structural molecules in the interaction between microbes and tissues in the gut. The team is using a unique technology that combines gene sequencing, florescence microscopy, and comparative metabolomics to characterize how sphingolipids interact with the gut microbiome.
- Studying how gut microbial communities are tied to complex disease states, including obesity and inflammatory bowel diseases. This research traces the impact of nutrient sharing in gut microbial communities and hopes to identify interactions that could help guide dietary or other interventions to improve health outcomes.

Building Capacity for Nutrition Research

» Institutional Development Award Program**:** NIGMS, through the congressionally mandated Institutional Development Award (IDeA) program, supports research capacity building in states and jurisdictions that have had historically low levels of NIH funding. One component of IDeA, the Centers of Biomedical Research Excellence (COBRE) program, supports the establishment and development of biomedical and behavioral research centers at institutions in IDeA-eligible states. Several of these COBREs have nutrition-related programs and clinical trials, and some COBREs, such as the Kansas Center for Metabolism and Obesity Research, directly focus on building the research workforce and physical infrastructure for nutrition-related research. Examples include—

- Building infrastructure to investigate new treatments for obesity, metabolic dysfunction, and obesity-related complications
- Supporting capacity building for nutrition and obesity research, particularly as it relates to the identification of biological food-borne signals that could prevent, treat, and cure obesity and obesity-related diseases
- Building capacity for precision nutrition research to explore how genes, environment, culture and customs, dietary preferences, and economics all contribute to nutrition and overall health

» **Science Education Partnership Award:** The NIGMS-led Science Education Partnership Award (SEPA) program supports educational activities that encourage pre-college students (pre-kindergarten through grade 12) from diverse backgrounds to pursue further studies in science, technology, engineering, and mathematics (STEM). SEPA focuses on two types of projects: (1) classroom-based projects for students and teachers and (2) the use of science centers, libraries, and museum exhibits for informal science education. A few SEPA projects have developed innovative education programs focused on childhood nutrition for students and their families. Examples include—

- Establishing a bilingual, culturally-appropriate curriculum for educating preschool children in early childhood care and learning centers who are from underrepresented groups and low-income households, as well as their families and teachers, on childhood nutrition. The curriculum, which was nationally distributed following its conclusion, addresses food access in these communities to reduce disproportionate rates of poverty, hunger, and malnutrition.
- Supporting elementary school students' interest in STEM and improving food literacy by connecting STEM and increasing school lunch consumption. Professional development workshops and resources for teachers combine inquiry-based STEM education with evidencebased nutrition education to increase students' STEM and food-related interest and literacy and school lunch consumption.

National Institute of Mental Health

https://www.nimh.nih.gov

OVERVIEW

The mission of the National Institute of Mental Health (NIMH) is to transform the understanding and treatment of mental illnesses through basic and clinical research, paving the way for prevention, recovery, and cure. NIMH supports biomedical and behavioral research, health services research, research training, and health information dissemination with respect to the causes, diagnosis, treatment, management, and prevention of mental illnesses. As mental health is an important part of overall health, NIMH invests in research on adaptive and maladaptive behaviors to better understand mental function and dysfunction.

KEY ACHIEVEMENTS

- Chatbot Encourages People With Eating Disorders to Seek Care**:** As detailed in an April 2023 NIMH Research Highlight, researchers in a new NIMH-funded study developed a chatbot to encourage people with eating disorders to connect with care. The researchers found that participants were open to the chatbot and able to successfully use it, suggesting its potential as a highly scalable tool to improve motivation and help-seeking behaviors among individuals with eating disorders. This study is the first in a planned three-part series, which includes a preparation phase, an optimization phase, and an evaluation phase.
- Treatment of eating disorders: A systematic meta-review of meta-analyses and network meta-analyses: Co-authored by an NIMH grant recipient, this November 2022 publication in the journal Neuroscience & Behavioral Reviews systematically assessed a large body of research on the treatment of eating disorders to inform clinical care and future research.

RESEARCH DIRECTIONS

NIMH encourages and supports a variety of nutrition-related research areas and projects in human and animal subjects. Examples of NIMH-funded research and areas of interest relevant to nutrition include the following:

- Exploring the role of the gut microbiome in such mental health conditions as anorexia nervosa, early-life trauma, and depression
- Understanding the endocrine and neural mechanisms underlying avoidant or restrictive food intake disorder
- Examining the effect of brain metabolic abnormalities on cognitive function and illness trajectory among individuals at clinical high risk for psychosis
- Using continuous glucose monitoring to detect and intervene on risk and maintenance factors associated with binge-eating psychopathology
- Using remote active and passive data-collection technologies and advanced analytic techniques to identify patterns that signal an impending binge or purge episode in individuals with bulimia nervosa or binge-eating disorder, potentially laying the foundation for personalized precision treatment
- Understanding how omega-3 fatty acid docosahexaenoic acid (DHA) traverses the blood–brain barrier to enter the brain, potentially aiding drug delivery to the brain
- Exploring the effects of maternal obesity and poor antenatal nutrition on offspring cognition, emotion regulation, and risk for neurodevelopmental disorders
- Testing dietary interventions for people with serious mental illness who are overweight or obese to produce clinically significant weight loss and reduce cardiometabolic risk
- Testing the effectiveness of digital health interventions for eating disorders
- Understanding how food insecurity influences risk, resilience, and clinical care for mental illnesses

National Institute on Minority Health and Health Disparities

https://www.nimhd.nih.gov

OVERVIEW

The mission of the National Institute on Minority Health and Health Disparities (NIMHD) is to improve minority health and reduce health disparities. NIMHD fulfills its mission through the conduct, coordination, and support of research on minority health and health disparities. In addition, NIMHD is committed to training a diverse scientific workforce, disseminating research information, and fostering innovative collaborations and partnerships. NIMHD works to ensure that all populations can live long, healthy, and productive lives—especially populations that experience health disparities, including disparities in nutrition and dietary-related areas. These populations include African American or Black, American Indian and Alaska Native, Asian, Hispanic or Latino, Middle Eastern and North African, Native Hawaiian and Pacific Islander, sexual and gender minority, low-socioeconomic status (SES), and underserved rural populations, as well as people with disabilities.

In addition to implementing its own strategic plan, NIMHD leads the coordination of the NIH Minority Health and Health Disparities (MHHD) Strategic Plan with the NIH institutes, centers, and offices (ICOs). Together, NIMHD and the ICOs are implementing the goals and strategies of the NIH MHHD Strategic Plan through scientific research, capacity-building, training, outreach, and dissemination efforts to improve minority health and reduce health disparities. Recognizing that many factors—including behavior, the environment, and social influences—contribute to nutritionrelated health disparities and are more prevalent among certain segments of the population (e.g., racial and ethnic minority groups, individuals of low SES), NIMHD is committed to a multidisciplinary approach to address dietary-related disparities, including diseases and conditions that are linked to nutrition, such as diabetes, obesity, hypertension, cardiovascular disease, and cancer.

KEY ACHIEVEMENTS

During fiscal year 2022 (FY22) and FY23, NIMHD funded several projects related to nutrition research. Some of the primary areas of focus included food insecurity; access to food, including nutritious food; dietary patterns; improvement of diet and physical activity; and prevention or treatment of obesity, cancer, cardiovascular diseases, and diabetes. NIMHD-funded projects used different approaches, including community-based participatory research and implementation science to address nutrition research at the individual, interpersonal, and societal levels through policy research, collaborations with school systems and health professionals, and engagement with the community. This section highlights some of the key research accomplishments during the reporting period.

In one study, researchers found disparities in health and economic burdens of cancer attributable to suboptimal diet in the United States. The study estimated the number of new cancer cases and cancer deaths and the economic costs of 15 diet-related cancers attributable to suboptimal intake of seven dietary factors (a low intake of fruits, vegetables, dairy, and whole grains and a high intake of red and processed meats and sugar-sweetened beverages). Results showed that suboptimal diet was estimated to contribute to 3.04 million new cancer cases, 1.74 million cancer deaths, and $254 billion in economic costs among U.S. adults age 20 years or older over a lifetime. Compared with other population subgroups, younger adults, men, African American or Black people, individuals with lower educational attainment, and individuals with lower household incomes had higher diet-attributable cancer burdens, particularly due to high consumption of sugar-sweetened beverages and low consumption of whole grains. The results suggest that more work is needed to address suboptimal diet among young adults, men, racial and ethnic minority populations, and socioeconomically disadvantaged groups in the United States to reduce the burden of cancer.

Another study found that insufficient lycopene intake is associated with high risk of prostate cancer. Lycopene is a plant nutrient that is related to beta-carotene and gives some vegetables and fruits a red color. It is also an antioxidant that may help to protect cells from damage. Recent studies have found that African American or Black patients with prostate cancer derive less benefit than White patients from a lycopene intake intervention program. Using data from the National Health and Nutrition Examination Survey for 2003 to 2010, this study sought to determine whether a lycopene intake–related racial disparity exists in reducing the risk of prostate cancer in healthy adults. Researchers examined total lycopene intake from daily diet, age, living status, race and

ethnicity, education level, poverty income ratio, body mass index (BMI), and smoking status. Results showed that African American or Black men consumed less lycopene and had a higher risk of prostate cancer than White men. Among the entire sample, race and ethnicity were the only factors that influenced lycopene intake from the daily diet. Sufficient lycopene intake from daily food was protective against prostate cancer only among White men. More research is needed to explore the dose-response relationship between lycopene intake and the association of prostate cancer risk in African American or Black men.

The Supplemental Nutrition Assistance Program (SNAP) is one example of the federal government's strategy to address food insecurity. One study examining the association of local or state immigrant-criminalizing policy on food insecurity and health through SNAP enrollment among immigrant Hispanic or Latino populations found that county- and state-level immigration policies are associated with SNAP participation among Hispanic or Latino households. In counties with sanctuary policies, immigrant Hispanic or Latino populations had a higher rate of participation in SNAP compared to cities without a sanctuary policy, suggesting immigrant policies have implications for enrollment in SNAP and food insecurity overall.

In New York City, taxi drivers have higher rates of obesity than New Yorkers in general and have high rates of elevated waist circumference, sedentary behavior, poor diets, and underutilization of health care services. A newly funded project, Taxi ROADmAP (Realizing Optimization Around Diet And Physical activity), utilizes the Multiphase Optimization Strategy to develop a scalable lifestyle intervention through implementation science to address weight loss among low-SES, multilingual immigrant taxi drivers.

The Osage Community Supported Agriculture Study (OCSA) initiated recruitment for its randomized controlled trial to test the Indigenous Supported Agriculture (ISA) program's effect on diet, blood pressure, and blood lipids. Secondarily, the program will study the effect on BMI, hemoglobin A1c (HbA1c), food insecurity, and health status among American Indian families with overweight or obesity. The investigators also will assess the cost-effectiveness and cost benefit of the ISA program by performing a health economics analysis for individual (e.g., health-related quality of life), organizational (e.g., health care utilization costs), and community-level (e.g., prevention of cardiometabolic diseases) outcomes.

In the Mississippi Delta, a multilevel community-engaged intervention seeks to strengthen the local food economy to make it sustainable and equitable with food is medicine offerings. The study aims to determine whether an intervention developed with a multisector Delta Policy Food Council to increase the production of local fruits and vegetables, and programs to address the connection between nutrition and the development of chronic diseases, can increase the consumption of fruits and vegetables to improve minority health and reduce health disparities among a rural population. Investigators expect to create a scalable and replicable food economy model to reduce obesity and improve diabetes; the model also will include policy recommendations for state and federal legislative leaders.

RESEARCH DIRECTIONS

NIMHD-funded research continues to focus on addressing food insecurity, lack of access to healthy foods, diet-related chronic diseases, and social determinants of health; supporting training and diversification of the nutrition research workforce; advancing the use of information technology (including mobile apps); and using innovative approaches, such as the arts, as strategies to improve nutrition-related health outcomes. Below are examples of new and ongoing NIMHD nutrition-related research.

The Effects of DASH Groceries on Blood Pressure in Black Residents of Urban Food Deserts project will examine whether virtual supermarkets with home delivery can be leveraged to meaningfully improve diet and blood pressure in an urban food desert. Investigators will perform a 12-week, individual-level, randomized trial to determine the health effects of complete dietary replacement with home-delivered, low-sodium groceries that participants will order virtually with dietitian assistance, based on the Dietary Approaches to Stop Hypertension program. The study will also test the effects of groceries on systolic blood pressure and secondarily on cardiovascular disease risk factors. The goal is to establish a scalable, patient-oriented solution that overcomes poor access to healthy foods and addresses health disparities.

Registered dietitian nutritionists (RDNs) are trained to follow evidence-based nutrition practice guidelines in caring for patients with advanced-stage chronic kidney disease who are on dialysis. However, there has been little evaluation of best practices for implementing these guidelines. In the article Evaluating the Implementation of Evidence-Based Kidney Nutrition Practice Guidelines: The AUGmeNt Study Protocol, researchers discuss a study focused on implementing evidence-based nutrition practice

guidelines. In this study, RDNs will document initial and follow-up nutrition care for patients with chronic kidney disease receiving dialysis treatment using the Academy of Nutrition and Dietetics Health Informatics Infrastructure. Participants will be randomly assigned to one of two training models—either (1) evidence-based nutrition practice guidelines knowledge training or (2) evidence-based nutrition practice guidelines knowledge training—and will also be given an implementation toolkit. Investigators will examine the congruence of RDN documentation of nutrition care with the evidence-based nutrition practice guidelines describing common RDN-reported guidelines acceptability, adoption, and adaptation issues, and determining the feasibility of estimating the impact of RDN care on nutrition-related patient outcomes. The AUGmeNt study can inform effective development and implementation of future evidence-based nutrition practice guidelines.

The Center to Improve Chronic disease Outcomes through Multilevel and Multigenerational approaches Unifying Novel Interventions and Training for health EquitY (The COMMUNITY Center) seeks to reduce health disparities in chronic diseases in the New York City region working with community health workers to enroll participants in the Center's research studies and provide services related to food insecurity, housing instability, transportation, utility needs, and access to insurance. One study from the Center, the Community Health Workers United to Reduce Colorectal Cancer and Cardiovascular Disease Among People at Higher Risk (CHURCH), aims to reduce disparities in colorectal cancer (CRC) screening and cardiovascular disease risk factors linked to increased risk of CRC. In partnership with 22 African American or Black churches in New York City, the cluster randomized controlled trial will assess the effect of a Culturally Adapted Community health workers-linked Alive! (CACA) program on CRC screening uptake and dietary inflammation score, and secondarily, on changes in Life's Simple 7 scores at 6- and 12-months post-intervention. Findings of this study will provide insights into multilevel facilitators and barriers of screening uptake and the potential for scaling up the intervention.

Rural populations and people living in low-income households have high rates of obesity. The southern United States has the greatest disparities in obesity prevalence between urban and rural counties. Another study, Evaluation of a Comprehensive School Nutrition Enrichment Intervention (CSNEI) in Rural School Districts, is a randomized trial evaluating a CSNEI in six rural school districts involving 11,500 students who are eligible for free and reduced-price meals. The study also explores heterogeneity of treatment effects for race, ethnicity, sex, age, and economic status to understand the effects on populations most at risk for obesity. Through this study, researchers are evaluating the short-term and long-term effects of a CSNEI on the nutritional quality of food served in school meals, students' food consumption, and students' skin carotenoid levels as an indicator of fruit and vegetable intake.

Studies have found that high dietary quality is protective against cancer, but a paucity of research exists on the role of independently owned restaurants in potentially contributing to cancer prevention in predominantly racial and ethnic minority, low-income urban communities. Systems Science Approaches to Improve Access to Healthier Foods: The FRESH Trial aims to sustainably improve access to healthier foods in independently owned restaurants. The study will (1) test the effects of a novel intervention called FRESH (Focus on Restaurant Engagement to Strengthen Health) on dietary quality, health indicators, and other outcomes in African American or Black and Hispanic or Latino communities in Baltimore and Washington, D.C.; and (2) develop a system dynamics model to allow stakeholders to virtually test FRESH strategies in their own communities.

TRAINING

NIMHD supports the diversification of the nutrition research workforce through career development awards, fellowships, and other training programs that will help to expand nutrition research focused on minority health and health disparities. Select examples of the research training activities of NIMHD-funded scholars include:

Produce Prescriptions and Group Medical Visits: Addressing Food Insecurity and Social Isolation in Primary Care is studying the effectiveness and implementation of primary care interventions to address disparities in food insecurity and social isolation among adults with chronic conditions using mixed-methods research. The proposed research will assess an innovative model of care that provides prescriptions for fresh fruits and vegetables with or without group medical visits (GMVs) to ethnically and linguistically diverse, low-income patients. Findings of this study will inform the development of a clinical trial focused on how GMVs with food access components influence health outcomes and social needs over time among patients at federally qualified health centers.

Community Violence and Its Impact on Food Retail, Food Purchasing Behavior, and Dietary Intake Among Low-Income African Americans seeks to examine community violence and its influence on food retail, food purchasing behavior, and dietary intake in

low-income African American communities with a high violent crime rate in Chicago. This research will increase understanding of how community violence affects nutrition at the individual and community levels.

Increasing and Diversifying Future AI-Precision Nutrition Research Workforce to Promote Nutrition Health Equity Among Underserved Populations is funded through the NIH AI-Precision Nutrition (AIPrN) program to support the development of a predoctoral and postdoctoral AIPrN research training program at a Historically Black College and University that will provide multidisciplinary training in computational data skills and precision nutrition. To address nutrition-related health disparities, the AIPrN research training program will (1) recruit, train, and financially support predoctoral students and postdoctoral fellows from populations that are underrepresented in artificial intelligence and machine learning or nutritional science; (2) develop and enhance the research training program and provide technical assistance and mentorship opportunities for trainees; and (3) provide professional development and foster leadership skills in AI-Precision Nutrition for trainees who want to apply for fellowships or grants and transition to research-intensive careers.

Influence of Dietary Pattern and Race on Metabolic and Epigenetic Alterations Associated with Cancer Development is a research project that will elucidate the role of dietary patterns in cancer disparities and ultimately foster the development of effective interventions for cancer prevention. Using data from healthy participants in the Adventist Health Study-2 cohort, the project will examine the independent and combined influences of vegetarian versus omnivorous dietary pattern and race on metabolic and epigenetic changes among African American or Black and White participants. The proposed project also will provide new training in molecular epidemiology, genomics, and health disparities research.

Sabor que Sana: Evaluation of a Traditional Mexican Dietary Pattern and NAFLD Risk in Mexican-Origin Hispanic Adults sought to determine whether effective dietary interventions can be developed and implemented to reduce the burden of nonalcoholic fatty liver disease (NAFLD) among Mexican adults. One project studied the association between the traditional Mexican diet score and hepatic steatosis and fibrosis and found that higher adherence to a traditional Mexican diet was associated with lower hepatic steatosis in U.S.-born Hispanic or Latino adults of Mexican descent with overweight and obesity. Findings from the current work may serve to inform future culturally relevant interventions for NAFLD prevention and management in individuals of Mexican descent.

TOOLS AND RESOURCES

The NIMHD HD*Pulse* is an ecosystem of minority health and health disparities resources. The HD*Pulse* Data Portal facilitates identifying, tracking, and studying issues related to minority health and health disparities. The HD*Pulse* Data Portal can support a wide range of individuals, including scientists, policy leaders, clinicians, community health workers, educators, and public health practitioners, to identify health disparities; examine determinants of health disparities; as well as plan, develop, implement, and evaluate interventions to improve minority health and reduce health disparities. *Diet and Exercise* is one of the searchable health determinant topics in the HD*Pulse* Data Portal.

National Institute of Neurological Disorders and Stroke

https://www.ninds.nih.gov

OVERVIEW

Created by the U.S. Congress in 1950, the National Institute of Neurological Disorders and Stroke (NINDS) has occupied a central position in the world of neuroscience for nearly 75 years. The mission of NINDS is to seek fundamental knowledge about the brain and nervous system and to use that knowledge to improve the neurological health of all people. The institute supports and performs basic, translational, and clinical research on the brain and nervous system; fosters the training and career development of investigators in the basic and clinical neurosciences; seeks better understanding, diagnosis, treatment, and prevention of neurological disorders; and disseminates scientific discoveries to the public, health professionals, researchers, and policymakers (*2021–2026 NINDS Strategic Plan*). NINDS supports research on the interaction between nutrition and the nervous system. This includes mechanistic studies that investigate the role of nutrients or metabolic processes in neurological conditions or in healthy neurons, as well as preclinical and clinical studies that test behavioral-, pharmacological-, and technology-based interventions.

KEY ACHIEVEMENTS

Publications

There are substantial health disparities in blood pressure control, which is a major risk factor for stroke, heart disease, and dementia; for example, Black individuals are twice as likely to have uncontrolled hypertension compared to White individuals. In 2022, researchers published positive primary results from the "Shake, Rattle & Roll" cluster randomized clinical trial, which compared the effect of three interventions on blood pressure control in 1,761 Black adults: a culturally tailored and personalized diet and lifestyle coaching intervention, an enhanced medication adherence protocol, and usual care.[1] Lifestyle coaching consisted of a telephone-based lifestyle intervention focused on the Dietary Approaches to Stop Hypertension (DASH) diet. The group receiving lifestyle coaching achieved better blood pressure control compared with usual care at 24 and 48 months after enrollment, whereas the group receiving enhanced pharmacotherapy did not.

Loss of control eating, or binge eating, is common and is known to compromise even the most aggressive of obesity treatments, such as bariatric surgery. Promising pilot study results were reported in 2022 from an NIH Brain Research Through Advancing Innovative Neurotechnologies® (BRAIN) Initiative project which is examining whether brain stimulation can curb binge eating.[2] Researchers electrically stimulated brain circuitry thought to be involved in loss of control eating using a novel, smart electrical stimulator implanted into the brain. Over 6 months, the team tested their deep brain stimulation protocol in two participants and observed improved self-control of food intake, as well as weight loss.[3] These early results support the continued clinical testing of this novel technology-based intervention in a larger pool of participants.

Scientists have generated conflicting evidence on whether people with Parkinson's disease (PD) experience early disease-based changes in their gut microbiome—the ecosystem of microbes, including bacteria, that live in the intestines and play an important role in health and disease. In a 2023 article, NINDS-supported researchers reported results from a rigorously designed case–control study nested within two large prospective epidemiological cohorts.[4] They identified overall shifts in the gut microbiome, including changes in several specific bacteria, in individuals with early, prodromal Parkinson syndrome, as well as more advanced PD. They demonstrated that microbiome alterations characteristic of recently onset PD are similar to those in the prodromal phase, which is the time very early in the disease course that precedes symptoms. These findings suggest that changes in the microbiome—which can potentially be modified via diet, nutritional supplements, anti- and probiotics, and other means—could represent novel biomarkers and treatment targets for the earliest phases of PD.

RESEARCH DIRECTIONS

Rapid and recent progress in brain research has yielded new insights on the interaction between nutrition and the nervous system.

[1] https://pubmed.ncbi.nlm.nih.gov/35583869
[2] https://pubmed.ncbi.nlm.nih.gov/36038628
[3] https://reporter.nih.gov/project-details/10464428
[4] https://pubmed.ncbi.nlm.nih.gov/37314861

Major areas of NINDS-supported nutrition research during FY22 and FY23 include the following:

- Basic research into how the brain controls feeding behaviors
- Basic research studies that examine the role of nutrients in brain health and development and a variety of neurological disorders and brain injury, including cerebrovascular disease, dementia, diabetic neuropathy, amyotrophic lateral sclerosis (ALS), cerebellar ataxia, multiple sclerosis, traumatic brain injuries, and metabolic brain disorders
- Mechanistic studies that investigate metabolic processes to better understand how cellular energy metabolism affects brain function and neurodevelopment
- Translational research studies that test dietary interventions or metabolic pathway–targeting molecules in animal models of neurological diseases, including pain conditions, ischemic stroke, Huntington's disease, dementia, ALS, neural tube defects, metabolic brain disorders, and epilepsy
- Research supported under the NIH BRAIN Initiative to develop nutrition-relevant neurotechnologies such as brain imaging, neural recording, and neuromodulation technologies (e.g., to measure energy metabolism in the brain and activation of specific brain areas involved in feeding behaviors)
- Studies that explore the role of the gut microbiome in Parkinson's disease, brain injuries, multiple sclerosis, epilepsy, and central nervous system autoimmunity and aim to understand how the gut microbiome—often influenced by nutrition and diet—may modulate the immune system and neural function
- Mechanistic studies that examine how altered metabolism or obesity may contribute to impaired neural function, including projects that aim to understand molecular mechanisms underlying conditions like diabetic neuropathy, obesity-related cognitive impairment, and obesity-induced damage to the brain's blood vessels
- Research projects focused on comorbid conditions, such as stroke in obese individuals or stroke in individuals with metabolic syndrome
- Clinical studies that test interventions to improve brain health, including diet-based, pharmacologic, and novel brain technologies

NUTRITION TRAINING

NINDS supports several training research awards[5] captured in the Nutrition category of the Research, Condition, and Disease Categorization system but has no nutrition-specific training programs in FY22 or FY23.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

In FY23, NINDS awarded a grant[6] to support the 8th Global Symposium on Ketogenic Therapies, organized by the University of California, San Diego. For some individuals with epilepsy, a high-fat ketogenic diet may be effective at reducing epileptic seizures even when anti-seizure medications prove ineffective. The Eighth Global Symposium on Ketogenic Therapies marks the 15th anniversary of the first NIH-funded global symposium on dietary therapies. The goals of the symposium are to advance the science and practice of ketogenic and related therapies across the globe, and importantly broaden collaborations, expand the clinical and basic-translational science involving metabolism-based treatments, and pave the way for future generations of the research workforce.

[5] https://reporter.nih.gov/search/a_pffXUw6kiJtBgQNEeI4g/projects
[6] https://reporter.nih.gov/project-details/10753748

National Institute of Nursing Research

https://www.ninr.nih.gov

OVERVIEW

The mission of the National Institute of Nursing Research (NINR) is focused on leading nursing science to solve pressing health challenges and inform practice and policy, optimizing health and advancing health equity into the future. NINR-supported research is innovative; applies the most rigorous methods; advances equity, diversity, and inclusion; tackles today's pressing health challenges; and stimulates discoveries to prepare for, prevent, and address tomorrow's challenges. NINR-supported science seeks to discover solutions to optimize health across clinical, community, and policy settings. More information can be found in the NINR 2022–2026 Strategic Plan.

KEY ACHIEVEMENTS

Nutrition is an area of interest for NINR, especially in the area of prevention and health promotion; through the lens of population and community health, access to nutritious, culturally congruent foods also is of interest to NINR. Finally, throughout the lifespan, nutrition plays a key role in determining one's general health and well-being.

An example of recent NINR supported research advances in nutrition includes the following:

» NINR-supported investigators examined obesity prevalence and dietary risk factors among Alaska Native preschool-aged children by analyzing intake of traditional food, ultra-processed food, fruits, and vegetables. Researchers found that 70 percent of the children were classified as having overweight or obesity status and that traditional food intake was associated with lower body mass index (BMI). These researchers consulted with local Tribal Elders to develop their intervention, called Back to Basics, which provided a home-based nutrition curriculum and Head Start center–based program to improve the nutritional quality of Alaska Native children's diets through reintroducing nutrient-dense traditional and nontraditional foods and reducing the consumption of sugar-sweetened beverages.

RESEARCH DIRECTIONS

In 2022 and 2023, NINR sponsored several nutrition-related funding opportunities. NINR led a funding opportunity to evaluate the impact of COVID-19 pandemic-related food and housing policies and programs on health outcomes in health disparity populations. The notice of funding opportunity focused on projects that identified and evaluated the ongoing and long-term health impacts of disruptions in food and housing security experienced during the pandemic and the role of targeted policy and programmatic actions in mitigating those impacts. Supported research is exploring the impact of these policy changes on underserved populations and those at risk for health and economic inequities. Research grants supported by these funding opportunities are examining the relationship between expanded federal food support for low-income families and mental health and the impact of the expansion and expiration of these expanded benefits on the nutritional quality of food purchased.

Other recent nutrition research efforts supported by NINR include a study where researchers collaborated with community groups to examine the impact on families' diet quality, food purchasing, and food insecurity of providing full-service mobile markets that visit low-income urban neighborhoods and offer discounted healthy foods.

Office of Data Science Strategy

https://datascience.nih.gov

OVERVIEW

The Office of Data Science Strategy (ODSS) leads implementation of the *NIH Strategic Plan for Data Science* through scientific, technical, and operational collaboration with NIH institutes, centers, and offices. Its mission is to catalyze new capabilities in biomedical data science by providing NIH-wide leadership and coordination for modernization of the NIH data resource ecosystem, developing a diverse and talented data science workforce, and building strategic partnerships to develop and disseminate advanced technologies and methods.

KEY ACHIEVEMENTS

- **Fiscal Year 2023:** ODSS supported three training programs aimed at leveraging artificial intelligence (AI) for precision nutrition, which the *2020–2030 Strategic Plan for NIH Nutrition Research* identified as a key need for solving the most pressing problems in nutrition and health.
- **Fiscal Year 2022:** ODSS contributed funds for the development of the Automated Self-Administered 24-hour (ASA24®) Dietary Assessment Tool, which is a free food diary web tool that helps patients track their eating habits and assists researchers, including those studying epidemiology, tracking food recalls, and teaching analysis of diet.

RESEARCH DIRECTIONS

Advanced Training in AI Training for Precision Nutrition: ODSS is supporting the Office of Nutrition Research's effort to establish new institutional training programs (predoctoral, postdoctoral, or both) in AI for Precision Nutrition (AIPrN) focused on the integration of precision nutrition, AI, machine learning (ML), systems biology, systems science, Big Data, and computational analytics. The goal is to build a future workforce that will be able to use growing data resources to tackle complex biomedical challenges in nutrition science that are beyond human intuition. It is expected that such research will lead to the development of innovative solutions to combat diet-related chronic diseases and nutrition disparities within the mission areas of the participating NIH institutes and offices. The vision for the AIPrN training program is to support the development of a diverse research workforce with advanced competencies in AI, ML, and data science analytics to apply to an increasingly complex landscape of Big Data, including molecular, organismal, community, and societal levels related to nutrition and diet-related conditions. Below are descriptions of the three institutional training programs being supported by ODSS.

- Interdisciplinary Systems-Based Training for Precision Nutrition: This training program will help predoctoral students and postdoctoral fellows acquire skills to apply AI techniques to big health data for precision nutrition. Success of this program will create a new generation of transdisciplinary nutrition and big data scientists who can extract new and actionable insights from voluminous and time-intensive data to personalize nutritional interventions to combat diet-related chronic diseases, obesity, diabetes, and fatty liver disease.
- The Hawaii Advanced Training in Artificial Intelligence for Precision Nutrition Science Research (AIPrN): This training program, with special attention to the unique populations found in Hawaii, will produce doctoral scientists with cross-disciplinary breadth and knowledge in AI for precision nutrition science research as innovators and leaders to improve nutrition health and prevent and treat nutrition-related chronic diseases.
- Artificial Intelligence and Precision Nutrition Training Program: This program proposes to implement a novel program to train the next generation of scientists in the domains of AI and precision nutrition to address the future needs for the nutrition workforce. Developing the AI workforce for precision nutrition would address a key need identified by the NIH Nutrition Research Task Force in the *2020–2030 Strategic Plan for NIH Nutrition Research.*

TOOLS AND RESOURCES

ASA24: The ASA24 Dietary Assessment Tool is a free, web-based tool that enables multiple automatically coded, self-administered 24-hour diet recalls and single or multiday food records, also known as "food diaries." ODSS provided support for a workforce to maintain the tool for patient and researcher use.

Office of Dietary Supplements

https://ods.od.nih.gov

OVERVIEW

The mission of the Office of Dietary Supplements (ODS) at NIH is to coordinate cutting-edge dietary supplement research across NIH Institutes, Centers, and Offices (ICOs) and other federal agencies. This effort aims to foster knowledge and optimize health throughout the lifespan.

Dietary supplements are widely used in the United States by individuals seeking to maintain or improve their health or reduce their risk of illness. In 2023, the U.S. dietary supplement market was estimated at $63.63 billion, with a growth rate of 3.9 percent, up from 1.9 percent in 2022.

The Dietary Supplement Health and Education Act of 1994 defined dietary supplements as "products intended to supplement the diet" and established ODS within NIH under the U.S. Department of Health and Human Services. ODS began operations in November 1995.

Scientists are studying dietary supplements to determine their value in maintaining good health. ODS coordinates and supports this research, assessing the benefits and risks of dietary supplements and communicating the findings to scientists, health professionals, and consumers. Additionally, ODS will continue to share advances in dietary supplement science and ensure access to public dietary supplement research resources, including databases. The *ODS Strategic Plan for 2025–2029* provides a blueprint for a coordinated dietary supplement research agenda at NIH.

KEY ACHIEVEMENTS

NIH Dietary Supplement Research Coordinating Committee

ODS established the NIH Dietary Supplement Research Coordinating Committee (DSRCC) in 2022 to increase collaboration among NIH ICOs whose programs include work that focuses on dietary supplements and the intersection of dietary supplement, natural product, and nutrition research. Chaired by the Director of ODS, the DSRCC provides research coordination through the exchange of programmatic and scientific information, collaborative planning, and the implementation of relevant activities and initiatives.

Special Interest Database on Iodine

ODS launched the Iodine Initiative in 2011 in response to concerns about inadequate iodine intake among U.S. women during pregnancy, a period of high physiological demand.

» Key activities of the initiative include the following:

- Convening state-of-the-science workshops and symposia
- Supporting the improvement of existing analytical methods and the development of new methods and standard reference materials for assessing iodine status
- Assessing U.S. population–level iodine intake and status by funding iodized salt collection and markers of iodine status in the National Health and Nutrition Examination Survey
- Providing funding opportunities for investigator-initiated iodine research

Summaries of the scientific literature on iodine for health professionals and consumers are available on the ODS website. During 2022 and 2023, ODS collaborated with federal partners to develop and release versions 2.0 and 3.0 of the USDA, FDA, and ODS-NIH Database for the Iodine Content of Common Foods. This database characterizes the iodine content of foods and dietary supplements and is being used to assess the iodine status of the U.S. population, including vulnerable subgroups, such as pregnant women.

RESEARCH DIRECTIONS

ODS aims to be the scientific authority and convening body for advancing the study of dietary supplements through facilitating collaborative, innovative, and productive partnerships across NIH. ODS has identified diverse populations, healthy lifespan, and

resilience as crosscutting themes around which new research initiatives will be developed. These themes reflect topics of high interest across NIH that intersect with dietary supplement research.

From 2025 through 2029, ODS research priorities are as follows:

» Advance the study of biological effects of dietary supplements on health across the lifespan.

» Advance the study of population-based dietary supplement use, related nutrient intake, and the supplements' effects on health.

» Advance the study of the composition, quality, stability, safety, and efficacy of dietary supplements and their ingredients.

ODS Co-Funding Research Support

The majority of the ODS budget supports research on dietary supplements in collaboration with many NIH ICOs. Since its inception, ODS has funded hundreds of conferences, workshops, and meetings on dietary supplements that help inform and direct research efforts for ODS and NIH.

For fiscal year 2022 (FY22), ODS provided $7.4 million in co-funding to 53 grants across 11 NIH Institutes and Centers (ICs). For FY23, ODS provided $10.8 million in co-funding to 68 grants across 13 NIH ICs. Further information is available on the ODS Grants and Funding webpage.

Centers for Advancing Research on Botanical and Other Natural Products (CARBON) Program

Since 1999, in partnership with the National Institute for Complementary and Integrative Health, ODS has funded multidisciplinary centers to study the health effects of botanicals at academic research institutions across the United States through the CARBON Program. These centers identify and characterize botanical ingredients; assess their biological activity and bioavailability; evaluate their effects in cells, animals, and people; help select botanicals to test in clinical trials; and provide a rich environment for training and career development. In 2022 and 2023 the CARBON Program funded to study *Centella asiatica* and ashwagandha (*Withania somnifera*). From the five CARBON Centers and three pilot project awards, there were 12 publications in 2022 and 16 in 2023. ODS also supported annual meetings of the CARBON investigators and interested NIH and other Agency staff on the NIH campus in Bethesda, Maryland, on September 29 and 30, 2022, and on July 27, 2023.

NUTRITION TRAINING

The Mary Frances Picciano Dietary Supplement Research Practicum

This practicum is a biannual, multiple-day educational opportunity offered by ODS that provides fundamental knowledge of dietary supplements. This intensive practicum provides a thorough overview and foundation of issues, concepts, unknowns, and controversies about dietary supplements and supplement ingredients. It also emphasizes the importance of scientific investigations to evaluate the efficacy, safety, and value of these products for health promotion and disease prevention, as well as how to conduct this type of research.

The practicum is open—at no cost—to selected faculty, graduate students, and research practitioners in such health-related disciplines as nutrition, food science, pharmacy, pharmacology and pharmacognosy, exercise science and kinesiology, medicine, dentistry, nursing, and complementary and alternative medicine. Preference is given to candidates who are full-time academic faculty, research practitioners, doctoral students, postdoctoral students, and fellows. Applications are also accepted from health care providers and scientists with a master's degree or higher whose work involves research with dietary supplements, master's-level students, and students in allied health schools. The practicum was held virtually in 2022 and 2023 and was attended by more than 500 participants each year.

ODS Research Scholars Program

Through the Research Scholars Program, ODS continues to support emerging NIH intramural scientists in conducting all types of biomedical research—including preclinical, clinical, behavioral, and epidemiological—in which the primary emphasis is the investigation of dietary supplements and/or their ingredients on the role of dietary supplements and/or their ingredients in health promotion and disease prevention. Emerging intramural scientists include early career or junior research scholars, scientists, clinicians, and fellows with at least 1 year of postdoctoral research experience. In 2022, ODS supported five scholars across five NIH ICs (the National Cancer Institute, National Institute on Aging, National Institute on Alcohol Abuse and Alcoholism, National Institute of Allergy and Infectious Diseases [NIAID], and National Institute of Environmental Health Sciences), with a total funding of $478,000. In 2023 ODS supported one scholar at NIAID, with a total funding of $97,000.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

ODS Seminar Series

This monthly webinar series, with participation throughout NIH and beyond, brings in expert speakers or panels from other NIH ICOs and institutions around the world to provide expert points of view on current topics of particular interest relevant to dietary supplements. The webinars are open to anyone and provide an opportunity for participants to ask questions. For the 2022–2023 seminar series, ODS hosted nine webinars on anemia, dietary supplement fraud, aging and immunology, food politics, diet and the microbiome, and other topics.

Assessing Intake of Food and Dietary Supplements in Older Adults: A Workshop Series

ODS funded this 2022 webinar series organized by the National Academies of Sciences, Engineering, and Medicine. The series explored best practices for assessing dietary intakes and aimed to harmonize and standardize these methods, particularly for adults aged 75 years and older. The webinars featured presentations and discussions providing guidance to researchers and clinicians. Key topics included the following: (1) demographic trends and the current state of research on nutritional assessment in aging populations, (2) recent studies and developments in dietary assessment tools for aging populations, (3) research on screening for undernutrition in aging populations, and (4) policies and the broader landscape surrounding the nutritional assessment of older adults.

Pathways to Prevention (P2P) Program: Nutrition as Prevention for Improved Cancer Health Outcomes

ODS co-sponsored this 2022 workshop with other NIH ICOs to assess the scientific evidence on how nutritional interventions affect cancer health outcomes and in 2023 released a report on evidence gaps and priorities for future research.

Precision Probiotic Therapies—Challenges and Opportunities

In 2022, ODS co-sponsored this 2-day workshop, which had the following goals: (1) identify gaps in our current understanding of the biology of the gut microbiota and of probiotics and (2) identify research questions and methodological challenges posed by those gaps. Knowledge developed through these activities provides a critical foundation for future research efforts to develop "precision probiotic therapies."

ODS Research Scholars Symposium

The FY21 group of scholars presented their research findings at the annual ODS Research Scholars Symposium held in February 2022.

Trans-NIH Resilience Working Group Winter Seminar: The Science of Bouncing Back from Health Stressors—Development and Application of the Duke Pepper Model of Physical Resilience

The Trans-NIH Resilience Working Group Winter Seminar was held in February 2022. Topics included maintaining independence and quality of life with age and the importance of the ability to recover after such health stressors as infections, illnesses, and injuries.

TOOLS AND RESOURCES

Dietary Supplement Fact Sheets

ODS makes accurate and up-to-date scientific information about dietary supplements available to researchers, health care providers, and the public through ODS dietary supplement fact sheets. These overviews of scientific research on dietary supplements and their ingredients (including vitamin D, omega-3 fatty acids, and weight-loss supplements) are available in versions for both health professionals and consumers. Consumer fact sheets are also available in Spanish. In 2022 and 2023, new or updated fact sheets were prepared for numerous topics, including multivitamin/mineral supplements, carnitine, vitamin A and carotenoids, zinc, folate, omega-3 fatty acids, dietary supplements in the time of COVID19, and more.

ODS Newsletters

In 2022 and 2023, ODS published 21 newsletters. These electronic publications are distributed through the ODS email list, which has more than 100,000 subscribers:

Director's Message: Highlights accomplishments and key announcements from ODS programs

ODS Update: Summarizes recent developments in dietary supplement science and includes news about ODS programs, staff publications and presentations, dietary supplement fact sheets, databases, meetings, and exhibits

The Scoop: Provides consumer-focused information about dietary supplements

Special Supplement: Includes announcements from ODS

Just the Facts: Announces the availability of new and updated dietary supplement fact sheets for consumers and health professionals

Analytical Methods and Reference Materials Program

The ODS Analytical Methods and Reference Materials (AMRM) program supports and accelerates the development, validation, and dissemination of analytical methods and reference materials to improve the chemical characterization of dietary supplements and their ingredients and metabolites. In 2022 and 2023, the AMRM program supported the production of 24 new reference materials, partnered with U.S. Department of Agriculture scientists to advance methods for ingredient identification, created a new publicly available database to help researchers choose appropriate reference materials, and continued its collaboration with the National Institute of Standards and Technology to administer three exercises of the Dietary Supplement Laboratory Quality Assurance Program to aid the dietary supplement analytical community in ensuring that measurements of vitamins, minerals, fatty acids, phytochemicals, and possible contaminants in dietary supplement ingredients and products are accurate and reliable.

Dietary Supplement Label Database

Developed by ODS, the Dietary Supplement Label Database (DSLD) catalogs all information printed on the labels of dietary supplement products sold in the United States. It includes images of product labels and serves multiple purposes: Health care providers can use it to determine the content of products their patients are taking, consumers can learn more about the ingredients listed on the Supplement Facts labels, and research scientists can derive nutrient intakes from supplements. Since 2011, ODS has been adding 18,000 new label records to DSLD annually. As of June 2024, the database contains 186,059 total label records. Of these, 111,444 are "on market" products currently sold in the United States, and 74,615 are "off market" products that are either no longer sold in the United States or have undergone significant label revisions warranting new records.

Centers for Medicare & Medicaid Services Medicare Current Beneficiary Survey, Dietary Supplements, Measures of Malnutrition and Frailty

ODS has been working with the Centers for Medicare & Medicaid Services to collect data on dietary supplement use, malnutrition, and measures of frailty in the Medicare Current Beneficiary Survey (MCBS). MCBS is a nationally representative survey that collects health and Medicare claims data from participants multiple times per year for up to 4 years. These data will be very helpful in assessing risk of malnutrition and frailty. Since the participants' data are linked to their Medicare claims data, information can be validated against claims data, with the possibility for outcomes also to be assessed.

National Center for Health Statistics–U.S. Centers for Disease Control and Prevention National Health and Nutrition Examination Survey, Dietary Supplements and Selected Nutritional Biomarkers

The ODS population studies program leads efforts to address methodological issues in assessing dietary and dietary-supplement intakes in epidemiological and other large studies. ODS has funded the collection of dietary supplement usage data and select nutritional biomarkers in the National Health and Nutrition Examination Survey (NHANES) since 1999. NHANES, a major program of the National Center for Health Statistics, part of the Centers for Disease Control and Prevention, assesses the health and nutritional status of adults and children in the United States. Dietary supplement use is prevalent in the United States and increases with age. Data from the NHANES 2017–March 2020 survey show that 58.5 percent of adults age 20 years and older and 34.8 percent of children ages 0–19 years take at least one dietary supplement.

Office of Disease Prevention

https://prevention.nih.gov

OVERVIEW

The mission of the NIH Office of Disease Prevention (ODP) is to improve public health by increasing the scope, quality, dissemination, and impact of prevention research supported by NIH.

ODP supports prevention research and training initiatives in nutrition research to help improve diet and nutrition, including modifiable risk factors that play a role in the prevention of many diseases, conditions, and causes of death. ODP provides co-funding support for clinical nutrition studies and innovative programs and projects that have the potential to inform the development and dissemination of effective dietary behavior change strategies, guidelines, and policies.

KEY ACHIEVEMENTS

Nutrition as Prevention for Improved Cancer Health Outcomes Pathways to Prevention Workshop

The Pathways to Prevention (P2P) Workshop: Nutrition as Prevention for Improved Cancer Health Outcomes was convened in July 2022 to assess the available scientific evidence for the effectiveness of providing nutritional interventions before or during cancer treatment to improve health outcomes for people with cancer. The goals of the workshop were to synthesize available evidence, identify research gaps, shape a research agenda, and develop an action plan to advance the field. Workshop activities and products inform future research and development of guidelines, support therapies, and services for preventive care. Workshop publications include the Independent Panel Report, Systematic Evidence Review, and Federal Partners Meeting Report.

The following institutes and offices co-sponsored the P2P workshop:

- National Cancer Institute
- National Institute on Aging
- *Eunice Kennedy Shriver* National Institute of Child Health and Human Development
- NIH Office of Dietary Supplements
- NIH Office of Disease Prevention
- NIH Office of Nutrition Research

As many as 80 percent of people with cancer experience malnutrition, but cancer-associated malnutrition may be preventable. Studies have shown that interventions like medical nutrition therapy can help people with cancer keep a healthy body weight, maintain strength, respond to cancer treatment, and have a better quality of life. Recommendations from the workshop highlighted the need for improved screening methods, studies on nutritional interventions, examination of biological mechanisms to design dietary approaches, and more research on body composition and weight management interventions.

In April 2023, ODP convened a meeting with representatives from relevant federal government agencies to discuss and identify strategies to address research needs and opportunities, recommendations from the workshop's independent panel, and next steps to advance the field. The resulting Federal Partners Meeting Report highlights opportunities and resources to help federal agencies and the research community address the independent panel's 17 recommendations. ODP also conducted a portfolio review of relevant NIH research activities in this topical area to quantify and characterize current research activities, inform the identification of potential research and funding gaps, and provide a baseline to measure against future progress.

The P2P program seeks to (1) expand its reach across NIH and other federal agencies through high-quality collaboration; (2) emphasize the rigorous review of evidence; and (3) work to sustain and evaluate its impact on research, policy, and public health over the long term.

Federal Collaborations and Interagency Activities

Older Individuals Collaborative Nutrition (OICN): The OICN is a network of nutrition experts and other health professionals across the federal government whose areas of expertise "touch the lives of older adults." The OICN is hosted by the Office of

Disease Prevention and Health Promotion and supported by an interagency planning committee. NIH ODP staff served as a planning committee member for this workgroup.

Healthy People 2030: The ODP provides advice on Healthy People activities, and our staff serve on the Federal Interagency Workgroup, the principal advisory body for the development of the Healthy People initiative. In addition, staff worked collaboratively with the Healthy People Nutrition and Weight Status workgroup and contributed toward several other activities, such as review of public comments and evidence-based resources, as well as disseminated Healthy People work at national conferences.

U.S. Preventive Services Task Force (USPSTF): The USPSTF is an independent volunteer panel of national experts that makes evidence-based recommendations about clinical preventive services, such as screening, counseling, and preventive medications. This work is coordinated by AHRQ, and ODP provides scientific input on draft research plans, draft evidence reviews, and clinical practice guidelines, including those focused on nutrition. ODP staff also disseminate information about high-priority evidence gaps for clinical preventive services identified by the USPSTF. One recommendation is currently in progress, on Food Insecurity: Preventive Services (developing the draft recommendation stage).

White House Conference on Hunger, Nutrition, and Health: ODP staff contributed significantly toward the planning and implementation of the conference, as well as the development of the national strategy document.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

ODP-Sponsored Nutrition-Related Webinars and Workshops

- The Global Food and Nutrition Insecurity Webinar Series
- Advancing Interventions for Adult Obesity to Promote Health Equity: State of the Science and Research Opportunities

Prevention in Focus webinars feature research talks from prevention science experts and thought leaders who are making advances in public health. In January 2023, Dr. Steve Gortmaker of Harvard presented on cost-effective interventions that can prevent obesity and chronic disease and improve health equity. In June 2023, this series featured Dr. Hilary Seligman of the University of California, San Francisco discussing the challenge and promise of "food is medicine."

Office of Research Infrastructure Programs

https://orip.nih.gov

OVERVIEW

The Office of Research Infrastructure Programs (ORIP) supports the NIH mission by providing a variety of research infrastructure and related programs that benefit researchers supported by many NIH institutes, centers, and offices. ORIP creates and maintains a variety of resources to advance biomedical research, ranging from animal models and biomaterials to scientific instruments and equipment to human expertise.

KEY ACHIEVEMENTS

Assessment of Various Standard Fish Diets on Gut Microbiome of Platyfish, *Xiphophorus maculatus*

» Diets developed specifically for aquatic models, such as zebrafish, can affect the gut microbiome composition and may not be optimal for other fish models.

RESEARCH DIRECTIONS

ORIP participates in the nutrition funding opportunity PA-20-227: Administrative Supplements for Research on Dietary Supplements. This program is designed to provide supplemental funds to relevant, active NIH-supported research projects to incorporate dietary supplement research that is within the scope of the parent project.

NUTRITION TRAINING

» Deciphering the Role of Gut Microbiome in Inflammatory Bowel Disease Using a Canine Patient-Specific Gut-on-a-Chip

The Mentored Research Scientist Career Development Award project will have direct implications for human diseases, as it will provide new insights into genetic alterations that initiate or maintain chronic inflammation in the gut. The findings can be applied to chronic conditions associated with disturbances of intestinal health, such as colorectal cancer, diabetes, and Alzheimer's Disease.

» A Model of Antibiotic-Induced Gut Dysbiosis and Depressive Symptomatology

The major goal of this Mentored Research Scientist Career Development Award project is to characterize changes in gut microbiome and function, as well as behavior, following antibiotic treatment. The project will determine if antibiotic treatment leads to an imbalance in bacterial composition or changes in its distribution in the gut, which will eventually cause behavioral changes consistent with depression.

» MicroRNA-375 Regulation of Enteroendocrine Cell Biology in Diet-Induced Obesity and Bariatric Surgery

This NIH Predoctoral National Research Service Award proposal aims to address the knowledge gap to determine the role of enteroendocrine cells (EEC) in regulating the effects of dietary and surgical interventions with obesity and bariatric surgery. These cells regulate appetite, glycemic regulation, and energy balance. This study will test the hypothesis that EEC-enriched microRNA can regulate the effects of diet.

Office of Research on Women's Health

https://orwh.od.nih.gov

OVERVIEW

The Office of Research on Women's Health (ORWH) is the first Public Health Service office dedicated specifically to promoting women's health research within and beyond the NIH scientific community. ORWH was established in September 1990. Congress assigned a far-reaching leadership role for ORWH by mandating that the ORWH Director:

- Advise the NIH Director and staff on matters relating to research on women's health
- Strengthen and enhance research related to diseases, disorders, and conditions that affect women
- Ensure that research conducted and supported by NIH adequately addresses issues regarding women's health
- Ensure that women are appropriately represented in biomedical and bio-behavioral research studies supported by the NIH
- Develop opportunities and support for recruitment, retention, reentry, and advancement of women in biomedical careers
- Support and advance rigorous research that is relevant to the health of women
- Ensure NIH-funded research accounts for sex as a biological variable

ORWH leads the creation and implementation of the *NIH-Wide Strategic Plan for Research on the Health of Women* in partnership with NIH institutes, centers, and offices (ICOs) and co-funds research on the role of sex and gender on health. ORWH also collaborates with NIH ICOs, the NIH Office of Extramural Research, and the NIH Office of Intramural Research to monitor adherence to NIH's inclusion policies, which ensure that women, members of racial and ethnic minority groups, and individuals of all ages are represented in NIH-supported clinical research.

ORWH's interdisciplinary research and career development initiatives stimulate research on sex and gender differences and provide career support to launch promising women's health researchers. These programs set the stage for improved health for women and their families, career opportunities, and advancement for a diverse biomedical workforce.

RESEARCH DIRECTIONS

Current activities include ORWH involvement in planning a workshop on prenatal dietary supplements, an ORWH–Office of Nutrition Research (ONR) collaboration on exploring nutrition and women's lifespan research gaps, and an ONR–ORWH–National Institute on Aging work group on nutrition and menopause.

Nutrition and Health Disparity Working Group: This working group seeks to advance NIH research to understand the interactions between diet, nutritional status, the environment, and biological and behavioral processes and how they contribute to health disparities. It will also encourage research on how to prevent and treat nutrition-related diseases and reduce health inequities. These activities will stimulate the development of research priorities that elucidate how diversity of all kinds—race, ethnicity, socioeconomic status, disability, sex, gender, gender identity, or geography—influences nutrition and health interrelationships.

ORWH is also participating in the NIH Office of Nutrition Research–led notice of special interest (NOSI) on Stimulating Research to Understand and Address Hunger, Food and Nutrition Insecurity (NOT-OD-22-135).

NUTRITION TRAINING

- ORWH participates in Advanced Training in Artificial Intelligence for Precision Nutrition Science Research (AIPrN) Institutional Research Training Programs (T32) (RFA-OD-22-027). ORWH staff participated in meetings convened by the ONR Director to discuss T32 applications submitted in response to the notice of funding opportunity.

NIH-SPONSORED NUTRITION CONFERENCES, SEMINARS, VIDEOCASTS, WEBINARS, WORKSHOPS, AND OTHER EDUCATION OPPORTUNITIES

- ORWH participated in and contributed to the NIH-supported workshop Advancing Health Equity Through Culture-Centered Dietary Interventions to Address Chronic Diseases.

Office of Strategic Coordination

https://commonfund.nih.gov

OVERVIEW

The Office of Strategic Coordination (OSC) manages the Common Fund, which supports bold scientific programs that catalyze discovery across all biomedical and behavioral research. The Common Fund launched *Nutrition for Precision Health, powered by the All of Us Research Program* (NPH) to advance nutrition research. In fiscal year (FY) 2023, enrollment began for NPH, a landmark initiative that will advance precision nutrition by developing algorithms to predict individual responses to foods and dietary patterns.

RESEARCH DIRECTIONS

Launched in FY22, NPH is a major ancillary study of the *All of Us Research Program* and will enroll at least 8,000 participants from diverse backgrounds to study how a range of factors, including genes, lifestyle, health history, the microbiome, and social determinants of health, influence a person's response to diet. Findings from NPH may one day allow health care providers to provide more tailored nutritional guidance.

Tribal Health Research Office

https://dpcpsi.nih.gov/thro

OVERVIEW

The Tribal Health Research Office (THRO) serves as the central point of contact at NIH for federally recognized American Indian and Alaska Native (AI/AN) Tribes throughout the United States and for Indigenous populations of the U.S. Territories and is the synergistic hub for all Tribal health research activities at NIH. THRO is focused on enhancing the capacity for health research in Native communities, promoting opportunities for the next generation of AI/AN researchers, and disseminating transparent and culturally aware information about NIH across biomedical, social, and behavioral research. THRO also provides technical support to the NIH Tribal Advisory Committee (TAC) and drives agencywide progress related to the NIH Strategic Plan for Tribal Health Research.

American Indians and Alaska Natives (AIs/ANs) are disproportionately affected by many chronic diseases, such as diabetes, hypertension, and certain cancers. AIs/ANs experienced much lower incidence rates of these diseases just 100 years ago. Causes of these diseases can be related to social and economic factors in addition to historical events, such as the forced removal of AIs/ANs from their homelands after the Federal Indian Removal Act of 1830 and the transition in the AI/AN diet from traditional foods—such as nuts, beans, game, and fish—to the U.S. government–issued food commodities of lard, sugar, and canned meats. We now also see the disproportionate existence of food deserts in underserved communities, including reservations and adjacent lands, with many AI/AN elders experiencing food insecurity.

THRO will work with the NIH ICOs and Tribal communities to encourage research and programs focused on nutrition that incorporate traditional and cultural approaches to better nutrition and overall health.

TOOLS AND RESOURCES

THRO is currently coordinating efforts with the Office of the Assistant Secretary for Health to provide NIH resources on funding opportunities, toolkits, and information for a centralized U.S. Department of Health and Human Services (HHS) webpage. The webpage will provide Tribes and Native Serving Organizations a one-stop resource for opportunities across HHS agencies that focus on supporting AI/AN culturally tailored nutrition, exercise, and health programs and opportunities.

NIH REPORT AND REPORTER SEARCH METHODOLOGY

A APPENDIX

Appendix A: NIH RePORT and RePORTER Search Methodology

ABOUT NIH REPORT AND NIH REPORTER

In addition to carrying out its scientific mission, NIH exemplifies and promotes the highest level of public accountability. To that end, the RePORT website provides access to reports, data, and analyses of NIH research activities, including information on NIH expenditures and the results of NIH-supported research.

One tool available on the RePORT website is the RePORTER module. RePORTER is an electronic tool that allows users to search a repository of intramural and extramural NIH-funded research projects and access publications and patents resulting from NIH funding.

In addition to RePORTER, the RePORT website contains other tools that provide access to reports and summary statistics on NIH funding and the organizations and researchers involved in NIH research and training. One tool is the NIH Data Book, which summarizes the most commonly asked questions about the NIH budget and extramural programs. Another tool is Awards by Location, which summarizes NIH awards for a particular fiscal year by the location and organization of the awardees.

As described in the NIH Reform Act of 2006, Congress requires NIH to report annual spending for more than 300 research, condition, and disease categories, including Nutrition. Historically, projects related to Nutrition were identified by staff in each of the Institutes and Centers (ICs). However, at the request of Congress, NIH developed an improved process to provide better consistency and transparency in the reporting of its funded research. In fiscal year 2008 (FY08), NIH began using the Research, Condition, and Disease Categorization (RCDC) system to define more than 300 categories for which NIH reports annual spending to Congress and the public. The RCDC system uses sophisticated text data mining in conjunction with NIH-wide definitions to match projects to research spending categories.

The definitions (fingerprints) are a list of terms and concepts selected by NIH scientific experts to define a research category. The nutrition fingerprint, created by NIH staff and nutrition science experts representing several NIH ICs, was developed based on the Interagency Committee on Human Nutrition Research's definition of human nutrition research: *the pursuit of new knowledge to improve the understanding of nutrition as it relates to human health and disease and, as here defined, encompasses studies in five major areas—biomedical and behavioral sciences, food sciences, nutrition monitoring and surveillance, nutrition education, and impact on nutrition and intervention programs and socioeconomic factors*. The fingerprint is compared to each NIH-funded research project by searching titles, abstracts, and specific aims to generate a list of research projects related to nutrition. Because there is no reasonable way to assign a percentage of the project as relevant to nutrition, the dollars for all identified nutrition-related projects are counted as 100 percent relevant to nutrition. Research projects may meet the criteria of multiple fingerprints, and most nutrition projects also are categorized under other spending categories. For example, a project that meets the criteria for the nutrition, obesity, and prevention fingerprints would be included in each of the respective RCDC categories, so adding the number of projects or dollars in each category would result in a number that far exceeds the total number of projects or dollars.

SEARCH METHODOLOGY

The RePORT database was used to calculate total funding for Nutrition Research by NIH ICO using the RCDC category "Nutrition" under Categorical Spending. Categorical Spending displays the annual support level for various research, condition, and disease categories based on grants, contracts, and other funding mechanisms used across the NIH, as well as disease burden data.

Total funding in nutrition (nutrition research and training current dollars) restricted to FY22 and FY23 was the sum of nutrition research and training current dollars plus subproject funding (**Table 1**). The total nutrition research and training in current dollars by NIH component for FY22 and FY23 is provided in **Table 2**. Nutrition research and training in constant dollars was calculated using the Biomedical Research and Development Price Index (**Table 1**). Nutrition research and training in constant dollars for FY19, FY20, FY21, FY22, and FY23 was calculated by setting FY19 as 100 percent and multiplying the current dollar amounts for each fiscal year by the values within the Biomedical Research and Development Price Index (**Table 1**). The actual total NIH obligations and IC obligations for FY22 and FY23 were obtained from the NIH Budget Office *Actual and Total Obligations by Institute and Center history tables* (**Tables 1** and **3**). Constant nutrition dollars as a percentage of actual total NIH obligations by fiscal year

(Table 1) was calculated by taking the nutrition and research training constant dollars and dividing that value by actual total NIH obligations and multiplying the result by 100.

Figure 1 shows the percentage of nutrition research and training projects that overlap with other spending categories for FY21, FY22, and FY23. The RePORTER database was used to calculate the overlapping spending categories as a percentage of total funded projects in nutrition. The RCDC categories "nutrition" and "overlapping category" (e.g., prevention, obesity, cancer, microbiome) were used as Boolean terms to compute funding for those overlapping categories. The total number of projects is the sum of total funding plus subproject funding. Actual total NIH obligations were used to calculate the percentage of nutrition research and training current dollars, both for funding and number of projects.

Nutrition funding percentage by NIH research mechanism (Figure 2) was computed using the RePORTER tool and categorizing the search by funding mechanism. The RCDC term "Nutrition" was used for FY21, FY22, and FY23. The training categories (individual and institutional) were grouped into a single "training" category, and other research-related, Small Business Innovation Research/ Small Business Technology Transfer, and interagency agreements were grouped into the "other" category.

ACRONYMS FOR NIH INSTITUTES, CENTERS, AND OFFICES

B APPENDIX

Appendix B: Acronyms for NIH Institutes, Centers, and Offices

CC	Clinical Center
FIC	Fogarty International Center
NCATS	National Center for Advancing Translational Sciences
NCCIH	National Center for Complementary and Integrative Health
NCI	National Cancer Institute
NEI	National Eye Institute
NHGRI	National Human Genome Research Institute
NHLBI	National Heart, Lung, and Blood Institute
NIA	National Institute on Aging
NIAAA	National Institute on Alcohol Abuse and Alcoholism
NIAID	National Institute of Allergy and Infectious Diseases
NIAMS	National Institute of Arthritis and Musculoskeletal and Skin Diseases
NIBIB	National Institute of Biomedical Imaging and Bioengineering
NICHD	*Eunice Kennedy Shriver* National Institute of Child Health and Human Development
NIDA	National Institute on Drug Abuse
NIDCD	National Institute on Deafness and Other Communication Disorders
NIDCR	National Institute of Dental and Craniofacial Research
NIDDK	National Institute of Diabetes and Digestive and Kidney Diseases
NIEHS	National Institute of Environmental Health Sciences
NIGMS	National Institute of General Medical Sciences
NIMH	National Institute of Mental Health
NIMHD	National Institute on Minority Health and Health Disparities
NINDS	National Institute of Neurological Disorders and Stroke
NINR	National Institute of Nursing Research
NLM	National Library of Medicine
OD	Office of the Director
ODSS	Office of Data Science Strategy
ODS	Office of Dietary Supplements
ODP	Office of Disease Prevention
ONR	Office of Nutrition Research
ORWH	Office of Research on Women's Health
OSC	Office of Strategic Coordination
THRO	Tribal Health Research Office

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C APPENDIX

Appendix C: Acknowledgements

The Office of Nutrition Research (ONR) would like to thank the following individuals for assisting in the development and production of this report.

AUTHOR

Nicholas J. Jury, Ph.D., Director of Legislative Affairs and Policy, ONR, National Institutes of Health (NIH)

CONTRIBUTORS

Jill Beaver, Ph.D., Deputy Director, Office of Legislation, Policy, and International Activities (OLPIA), National Institute on Aging (NIA), NIH
David Bochner, Ph.D., Chief, Data Integration and Dissemination Branch, National Institute of General Medical Sciences, NIH
Andrew Bremer, M.D., Ph.D., M.A.S., Director, ONR, NIH
Laura Brockway-Lunardi, Ph.D., Chief, Science Policy Branch, National Institute on Alcohol Abuse and Alcoholism, NIH
Lawrence Brody, Ph.D., Director, Division of Genomics and Society, National Human Genome Research Institute (NHGRI), NIH
Alison Brown, Ph.D., M.S., RDN, Program Director, Clinical Applications and Prevention Branch, National Heart, Lung, and Blood Institute (NHLBI), NIH
Stephanie Burrows, Ph.D., Chief, Scientific Planning, Policy, and Analysis Branch, National Institute of Arthritis and Musculoskeletal and Skin Diseases, NIH
Sheila Caldwell, Ph.D., Senior Advisor, Tribal Health Research Office, NIH
Juliane Caviston, Ph.D., Health Science Policy Analyst, Office of Research on Women's Health (ORWH), NIH
Mindy Chai, Ph.D., Chief, Science Policy and Evaluation Branch, National Institute of Mental Health (NIMH), NIH
Jessica Cotto, M.P.H., Deputy Branch Chief, Science Policy Branch, National Institute on Drug Abuse, NIH
Stephanie Courchesne-Schlink, Ph.D., Senior Advisor to the Director, Office of Strategic Coordination (OSC), NIH
Sara Dodson, Ph.D., Senior Health Science Policy Analyst, Office of Science Policy & Planning, National Institute of Neurological Disorders and Stroke (NINDS), NIH
Regine Douthard, M.D., M.P.H., Senior Medical Officer, ORWH, NIH
Ali Ekram, Contractor, Office of Science Policy, Strategic Planning, Analysis, Reporting, and Data, National Institute on Minority Health and Health Disparities (NIMHD), NIH
Sarah Galvin, Ph.D., Chief, Science Policy, Planning, and Analysis Branch, *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, NIH
Nicole Garbarini, Ph.D., Deputy Director, Scientific Policy, Planning, and Evaluation, National Institute of Environmental Health Sciences (NIEHS), NIH
Shefa Gordon, Ph.D., Director, Office of Planning and Program Analysis, National Eye Institute, NIH
Jennifer Gorman Wright, M.P.A., Communications Director, ONR, NIH
Adrian Green, M.H.A., Program Analyst, Office of Research Infrastructure Programs, NIH
Brionna Hair, Ph.D., M.P.H., Health Science Policy Analyst, OSC, NIH
Adam Hartman, M.D., Program Director, Division of Clinical Research, NINDS, NIH
Andrew Hooper, Ph.D., Health Science Policy Analyst, Science Policy and Evaluation Branch, National Institute of Mental Health, NIH
Craig Hopp, Ph.D., Deputy Director, Division of Extramural Research, National Center for Complementary and Integrative Health (NCCIH), NIH
Bill Jirles, M.P.H., Program Analyst, NIEHS, NIH
Joanne Karimbakas, M.S., RN, Chief, Office of Health Communication and Public Liaison, National Institute on Deafness and Other Communication Disorders, NIH
Mary Beth Kester, M.S., Director, Office of Policy, Planning, and Evaluation, NCCIH, NIH
Sean Klein, Ph.D., Health Science Policy Analyst, Office of Data Science Strategy, NIH
Wendy Knosp, Ph.D., Chief, Science Policy and Planning Branch, National Institute of Dental and Craniofacial Research (NIDCR), NIH
Bramaramba Kowtha, M.S., RDN, LDN, Health Scientist, Office of Disease Prevention (ODP), NIH
Merel Kozlosky, M.S., RD, Manager, Metabolic Research, Nutrition Department, Clinical Center, NIH
Marya Levintova, Ph.D., Program Officer, Division of International Training and Research, Fogarty International Center (FIC), NIH
Allison McCague, Ph.D., Science Policy Analyst, NHGRI, NIH
Angela Malaspina, Ph.D., Health Scientist Administrator, Vaccine Research Program, Division of AIDS Research, National Institute of Allergy and Infectious Diseases (NIAID), NIH
Linda Nebeling, Ph.D., M.P.H., RD, Deputy Associate Director, Behavioral Research Program, National Cancer Institute (NCI), NIH
Stefan Pasiakos, Ph.D., Director, Office of Dietary Supplements (ODS), NIH
Calais Prince, Ph.D., Senior Health Science Policy Analyst, OLPIA, NIA, NIH
Felicia Qashu, Ph.D., Program Leader, OSC, NIH
Ryan Ranallo, Ph.D., Health Scientist Administrator, Enteric and Sexually Transmitted Infections Branch, NIAID, NIH
Jill Reedy, Ph.D., M.P.H., RDN, Chief, Risk Factor Assessment Branch, NCI, NIH

Heather Rieff, Ph.D., Director, Office of Scientific Program and Policy Analysis, National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), NIH
Sharon Ross, Ph.D., M.P.H., Program Director, Nutritional Science Research Group, Division of Cancer Prevention, NCI, NIH
Christina Samuel, Dr.P.H. Contractor, Office of Science Policy, Strategic Planning, Analysis, Reporting, and Data, NIMHD, NIH
Tara A. Schwetz, Ph.D., NIH Deputy Director for Program Coordination, Planning, and Strategic Initiatives, Director, Division of Program Coordination, Planning, and Strategic Initiatives (DPCPSI), NIH
Paul Scott, Ph.D., Director, Office of Science Policy and Planning, NINDS, NIH
Keisha Shropshire, M.P.H., Health Science Policy Analyst, ODP, NIH
Marushka Silveira, Ph.D., M.P.H., Contractor, Science Policy and Planning Branch, NIDCR, NIH
Megan Singh, Ph.D., Health Science Policy Analyst, NIDDK, NIH
Elizabeth Tarlov, Ph.D., RN, Director, Division of Extramural Science Programs, National Institute of Nursing Research (NINR), NIH
Nadra Tyus, Dr.P.H., M.P.H., Program Director, Transformative Health Disparities Program, NINR, NIH
Susan Vorkoper, M.P.H., M.S.W., Public Health Advisor, Division of International Science Policy, Planning and Evaluation, FIC, NIH
Courtney Wallin, Ph.D., Director, OLPIA, NIA, NIH
Edwina Wambogo, Ph.D., M.P.H., RD, Nutritional Epidemiologist, ODS, NIH
Mary Weston, Ph.D., Health Science Policy Analyst, Science Policy, Outreach, and Reporting Branch, NHLBI, NIH
Kester Williams-Parry, Ph.D., M.A., Program Analyst, Office of Science Policy, Strategic Planning, Analysis, Reporting, and Data, NIMHD, NIH

REVIEWERS

Samantha Adas, M.S., RDN, Program Analyst, ONR, NIH
Andrew Bremer, M.D., Ph.D., M.A.S., Director, ONR, NIH
Laura Cameron, Scientific Information Analyst, Office of Extramural Research (OER), NIH
Megan Donegan, Senior Scientific Information Analyst, OER, NIH
Tasha Espinoza, Budget Analyst, Office of Budget, NIH
Jennifer Gorman Wright, M.P.A., Communications Director, ONR, NIH
Robin Kawazoe, Deputy Director, DPCPSI, NIH
David Kosub, Ph.D., Senior Advisor for Legislative and Media Affairs, OER, NIH
Anna Mazzucco, Ph.D., Senior Advisor to the Director, DPCPSI, NIH
Grace McCarthy, Ph.D., American Association for the Advancement of Science, Science & Technology Policy Fellow, Special Assistant to the NIH Deputy Director for DPCPSI, NIH
Stephanie Mutchler, Ph.D., American Association for the Advancement of Science, Science & Technology Policy Fellow, NIDDK, NIH
Mara Olenick, Ph.D., Lead Scientific Information Analyst, OER, NIH
Betina Orezzoli Froehlich, M.B.A., Program Analyst, DPCPSI, NIH
Heather Rieff, Ph.D., Director, Office of Scientific Program and Policy Analysis, NIDDK, NIH
Judy Riggie, Director, Division of Scientific Categorization and Analysis, OER, NIH
Tara A. Schwetz, Ph.D., NIH Deputy Director for Program Coordination, Planning, and Strategic Initiatives, Director, DPCPSI, NIH
Michelle Shorter, Deputy Budget Officer, NIDDK, NIH
Megan Singh, Ph.D., Health Science Policy Analyst, NIDDK, NIH
Robert Tilghman, Ph.D., Health Science Policy Analyst, NIDDK, NIH

PRODUCTION STAFF

Lynne Agoston, Deputy Director of Editorial Services, The Scientific Consulting Group, Inc. (SCG)
Steve Boehm, Accessibility Specialist/Editor, SCG
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