Fiscal Years 2020–2022

Implementation Update Report

2020–2030 Strategic Plan for NIH Nutrition Research

National Institutes of Health
Turning Discovery Into Health

Table of Contents

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2020–2030 Strategic Plan for NIH Nutrition Research

Executive Summary

The *2020–2030 Strategic Plan for NIH Nutrition Research* (SPNNR) lays out four overarching strategic goals designed to further our understanding of how nutrition influences health and disease across the lifespan. This review serves as a progress check on the work that was supported by the National Institutes of Health (NIH) in fiscal years 2020, 2021, and 2022 (FY20–22) toward achieving these goals. The collection and analysis of research deliverables demonstrates progress toward meeting the first three strategic goals of the plan but revealed the potential for expanding opportunities related to Strategic Goal 4. Breaking down the analysis by the objectives contained within each strategic goal helps further identify areas for targeted growth. Tracking implementation over time and performing periodic analysis will allow potential strategic partnerships to be identified and pursued in a timely fashion to work toward achieving the vision defined in the SPNNR by 2030.

Introduction

Good nutrition is essential to living a long, healthy life, as a poor diet can lead to some of the most common, chronic, consequential, and costly health conditions. Across the lifespan, the foods we consume can have immense impact on our well-being, including both our physical and mental health. Improving the diet of all Americans could decrease the number of lives lost to chronic conditions and reduce annual health expenditures by billions of dollars. It is increasingly recognized that a one-size-fits-all approach to nutrition may be helpful for broad guidance, but variations in individuals' responses to dietary patterns—informed by genetics, age, health status, metabolism, and the microbiome—require implementation of more individualized or tailored approaches.

The *2020–2030 Strategic Plan for NIH Nutrition Research* (SPNNR) lays out a bold agenda for furthering our understanding of these unique responses and variations through the concept of "Precision Nutrition." This holistic approach to nutrition science allows the development of comprehensive and dynamic nutritional recommendations that can apply to both individuals and population health by accounting for genetics, dietary habits and eating patterns, circadian rhythms, health status, socioeconomic and psychosocial characteristics, food environments, physical activity, and the microbiome. Precision Nutrition recognizes that humans are inherently different from one another, meaning that healthy diets are not only about what we eat, but about when, why, and how we eat foods as well. This deeper understanding of nutrition solutions for individuals and population subgroups will have important implications for preventing diet-related diseases like obesity, diabetes, cardiovascular diseases, and cancers and will allow all Americans to live healthier lives.

Summary of the Plan

The SPNNR contains four overarching strategic goals further broken down into specific objectives:

> **Strategic Goal 1. Spur discovery and innovation through foundational research—*What do we eat and how does it affect us?*** Nutrition science requires a strong foundation of basic and methodological research to create evidence-informed guidelines and individualized strategies. Integrating other fields into nutrition research—including

bioinformatics, neurobiology, and genomics—accelerates our understanding of what we should eat as part of a healthy lifestyle and how these choices could affect individual people.

Objective 1-1. Address bioinformatic gaps in nutrition-related genes and pathways

Objective 1-2. Improve understanding of sensory nutrition and ingestive behaviors

Objective 1-3. Investigate diet–host–microbiome interrelationships

Objective 1-4. Identify and determine the effects of unknown metabolites arising from the microbiome and host metabolism of our food

Objective 1-5. Develop new tools for microbiome and precision nutrition research

Objective 1-6. Develop, refine, and integrate approaches to capture dietary data

Strategic Goal 2. Investigate the role of dietary patterns and behaviors for optimal health—*What and when should we eat?* Nutrients are not consumed in isolation but instead are part of dietary patterns that likely have interactive and synergistic effects. Advancing knowledge around what, when, why, and how we eat offers effective strategies to create and sustain nutrition-related behaviors conducive to optimal health.

Objective 2-1. Advance methods for dietary pattern analysis

Objective 2-2. Determine the mechanisms of interindividual variability in responses to food-based dietary patterns

Objective 2-3. Determine the health benefits and mechanisms of time-based dietary patterns

Objective 2-4. Discover and validate prognostic chronic disease biomarkers

Objective 2-5. Develop and validate algorithms to predict what all of us should eat

Objective 2-6. Leverage behavioral and implementation science to initiate and sustain healthy eating behaviors

Strategic Goal 3. Define the role of nutrition across the lifespan—*How does what we eat promote health across our lifespan?* Nutrition choices made today not only affect health in the near term but also throughout life. A better understanding of how nutritional needs and eating behaviors change throughout the lifespan helps promote health and prevent disease and guides strategies for parents and caregivers who feed others.

Objective 3-1. Examine the role of periconceptional and prenatal nutrition in development and disease outcomes

Objective 3-2. Enhance knowledge of human milk composition and the translational roles of its components

Objective 3-3. Assess the influence of diet and nutritional status on infant developmental and health outcomes

Objective 3-4. Develop predictive epigenetic tools

Objective 3-5. Assess the role of nutrition in older adults to promote healthy aging

Strategic Goal 4. Reduce the burden of disease in clinical settings—*How can we improve the use of food as medicine?* Medical conditions can alter the response to diet or nutritional requirements. Research is expanding knowledge about the role of nutrition in disease treatment, including the use of "food is medicine," to improve health outcomes and reduce the incidence of co-occurring diseases.

Objective 4-1. Identify interactions between drugs, disease states, and nutrition to improve clinical care and test strategies to improve clinical outcomes

Objective 4-2. Improve assessment of energy, protein, and micronutrient malnutrition to improve clinical outcomes

Objective 4-3. Identify clinical criteria for initiating and ceasing medical nutrition interventions for patients

The SPNNR also identifies important cross-cutting research areas—including health disparities; health of women; rigor and reproducibility; data science, systems science, and artificial intelligence (AI); and training the scientific workforce—that span all four of the strategic goals.

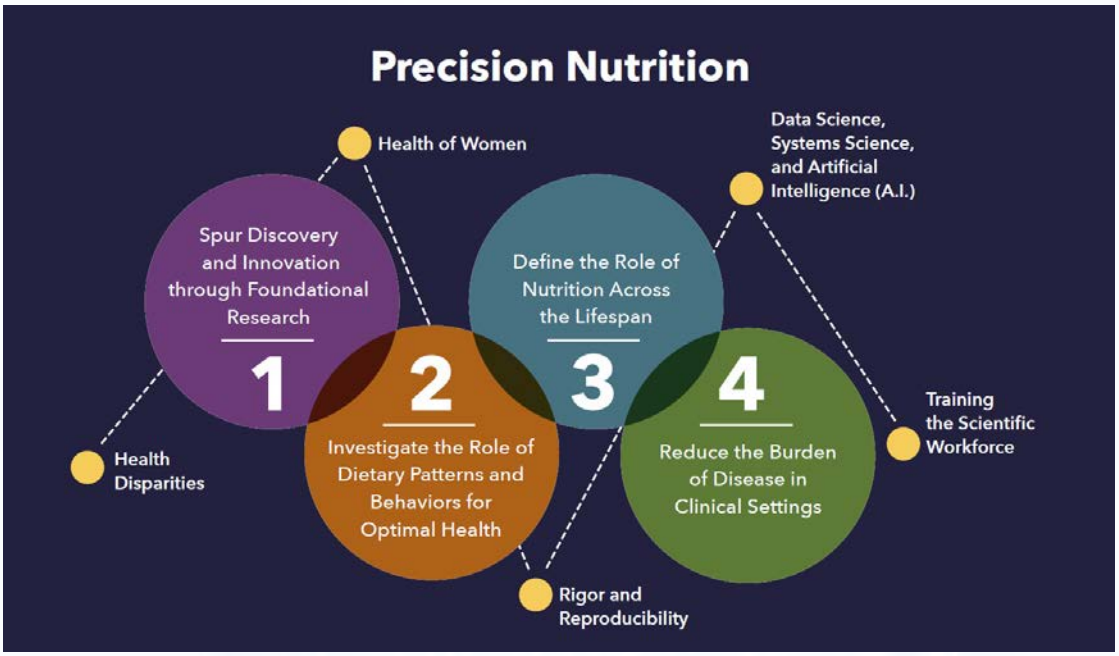

Figure 1. Summary of the strategic goals and cross-cutting research areas contained within the SPNNR

NIH Office of Nutrition Research—Moving the Plan into the Future

The NIH Office of Nutrition Research (ONR) is tasked with coordinating the implementation of the SPNNR. Founded in 2015 as part of the National Institute of Diabetes and Digestive and Kidney Diseases, ONR moved to the Division of Program Coordination, Planning, and Strategic Initiatives (DPCPSI) in the NIH Office of the Director (OD) in 2021, following release of the SPNNR. This move ensures ONR's ability to work across institutes, centers, and offices (ICOs) from within OD to ensure coordination of and leadership for nutrition research, given the broad impact that dietary patterns have on health and diseases. ONR works to identify research opportunities that warrant expanded effort and support by ICOs while also representing NIH on intradepartmental and interagency committees on nutrition research and related policy issues. It further serves as the lead advisor for NIH leadership and other key officials on matters relating to nutrition research.

The overarching goals of ONR (advancing science; supporting the generation of evidence to address priority diet, nutrition, and health outcomes; building capacity and strengthening the field of nutrition science; and fostering stewardship, collaboration, transparency, and accountability in nutrition science research), as detailed within the *Office of Nutrition Research Strategic Plan Fiscal Years 2026–2030*, synergize and complement the strategic goals contained within the SPNNR.

Implementation Review

This review serves as a progress check on the work that was supported by NIH in FY20, FY21, and FY22 toward achieving the goals laid out in the SPNNR. The collection and analysis of deliverables—including publications, research, clinical trials, workshops, and other items—help to identify where progress is being made and what opportunities exist for the future. Tracking implementation over time will also allow potential strategic partnerships to be identified and pursued in a timely fashion.

Methodology

To assess progress toward meeting the goals outlined in the SPNNR, a data call was sent to NIH ICOs in September 2023 through NIH's Strategic Tracking and Reporting Tool (START) requesting the submission of relevant deliverables (see Appendix A) from FY20–22. A total of 477 items were received from 31 ICOs, with each ICO designating the linked objectives and cross-cutting research areas for their submitted deliverables. There was no limit to the number of strategic goals, objectives, or cross-cutting areas to which each item could be linked. Submissions were reviewed, and deliverables that did not map clearly to the goals of the SPNNR were excluded from the analysis in this implementation update report. In total, 78 submitted deliverables were not included for analysis. The most common reasons for exclusion included a deliverable's having a focus on obesity or the microbiome without a proposed nutritional intervention or research question focused on contributing dietary factors. For analysis, deliverables that spanned multiple years were counted toward the data for each year the deliverable was active.

Heat maps were created to illustrate the percentage of deliverables linked to each strategic goal and objective. For each deliverable category, the percentage of items linked was calculated ([# of items mapping to objective/total # of specific deliverable type for that year] × 100), with the percentage displayed within the cells of the table. Some deliverable categories are not shown in heat maps due to a limited number of submissions within that category, while others have been combined with similar types of deliverables to create a more robust sample.

Importantly, the analysis in this report reflects only the deliverables that were reported by ICOs. Additional work that is not reflected in this report likely exists because nutrition research is embedded in a multitude of NIH programs that address health and disease within several body systems and populations. Investigator-initiated research (e.g., R01 projects) makes up a large portion of NIH funding; however, nutrition may be only one part of an aim, so the project is not readily identified as nutrition research. Therefore, while a robust sample was obtained for this analysis, it should be noted that it likely does not reflect the entire portfolio of NIH nutrition research. Further information about transformative and impactful research studies in nutrition related areas can be found in the *NIH Nutrition Research Report FY 2022–2023*.

Data and Analysis

Of the deliverables submitted, 105 were already established prior to FY20 but were still ongoing and applicable to the goals of the SPNNR; 160 were active in FY20, 228 were active in FY21, and 220 were active in FY22. The full breakdown by type of deliverable for each fiscal year is displayed in **Table 1.** The top five types of deliverables in descending order were as follows: research project, publication, research resource, notice of funding opportunity, and clinical trial.

Table 1. Number of deliverables submitted for each fiscal year (these include multiyear deliverables)

Type of Deliverable	Fiscal Year			
	Before 2020	2020	2021	2022
Clinical Study	4	6	6	6
Clinical Trial	10	11	11	13
Committee/Workgroup/Task Force	10	10	10	11
Conference/Meeting/Workshop	3	3	10	9
Notice of Funding Opportunity	3	8	22	16
Guideline	0	0	0	0
Initiative	6	6	9	6
Notice of Special Interest	0	3	3	3
Patent	0	1	0	0
Policy/Practice	0	0	0	0
Publication	1	20	31	26
Report	0	0	0	0
Request for Information	0	1	2	1
Research Project	53	76	103	107
Research Resource	13	11	14	15
Strategic Plan	0	1	2	1
Webinar	2	3	5	6

To illustrate how these deliverables link to the SPNNR, heat maps were created to indicate the percentage of items that fall within each of the four strategic goals. **Table 2** shows the percentage of all deliverables within a fiscal year that map to each of the Plan's four strategic goals ("Total" column), as well as the percentage of deliverables mapping to each of the individual objectives contained within the strategic goal. The analysis shows that while Strategic Goals 1, 2, and 3 have approximately one-third of deliverables mapping to them, Strategic Goal 4 has slightly less representation across the 3 years, with an average of 16 percent of deliverables per year. Within each of the strategic goals, one objective consistently has higher representation across all 3 years, including Objective 1-3 (investigate diet–host–microbiome interrelationships), Objective 2-6 (leverage behavioral and implementation science to initiate and sustain healthy eating behaviors), Objective 3-3 (assess the influence of diet and nutritional status on infant developmental and health outcomes), and Objective 4-1 (identify interactions between drugs, disease states, and nutrition to improve clinical care and test strategies to improve clinical outcomes).

Table 2. Percentage of total deliverables mapped to each strategic goal ("Total") and objective (e.g., 1-1, 1-2, 1-3,) per year

	Goal 1							Goal 2							Goal 3						Goal 4			
	Total	1-1	1-2	1-3	1-4	1-5	1-6	Total	2-1	2-2	2-3	2-4	2-5	2-6	Total	3-1	3-2	3-3	3-4	3-5	Total	4-1	4-2	4-3
2020	39	8	8	20	11	7	8	30	4	6	5	8	2	16	38	11	9	20	3	15	19	18	8	4
2021	37	6	6	17	7	6	11	30	6	6	4	5	1	17	37	11	7	16	2	15	14	12	6	4
2022	40	6	7	16	10	8	10	35	5	8	4	8	4	20	36	9	6	14	2	18	15	13	8	5

0–9%	10–25%	26–40%	41–55%	56–70%	71–100%

Table 3 displays the data further separated by the type of deliverable mapping to each of the four strategic goals within a year. Strategic Goals 1 and 3 are represented by almost all the different types of deliverables across the 3 years, while approximately three-quarters of the different deliverable categories map to Strategic Goal 2 within any year. While Strategic Goal 4 is the least represented overall, clinical studies, conferences/meetings/workshops, and webinars do have a large percentage of items that map to the strategic goal.

Table 3. Percentage of each deliverable that mapped to the strategic goals from FY20-22

	2020 Strategic Goal				*Total # of deliverables*	2021 Strategic Goal				*Total # of deliverables*	2022 Strategic Goal				*Total # of deliverables*
	1	**2**	**3**	**4**		**1**	**2**	**3**	**4**		**1**	**2**	**3**	**4**	
Clinical Study	17	0	33	50	*6*	17	0	33	50	*6*	17	0	33	50	*6*
Clinical Trial	9	27	64	27	*11*	9	27	64	27	*11*	15	46	62	15	*13*
Committee/ Workgroup/ Task Force	30	10	60	10	*10*	30	10	60	10	*10*	36	9	55	9	*11*
Conference/ Meeting/Workshop	67	0	33	67	*3*	10	10	50	10	*10*	44	22	33	56	*9*
Notice of Funding Opportunity	25	25	50	13	*8*	55	18	27	9	*22*	63	6	25	0	*16*
Guideline	0	0	0	0	*0*	0	0	0	0	*0*	0	0	0	0	*0*
Initiative	33	50	50	0	*6*	33	33	56	0	*9*	33	50	50	0	*6*
Notice of Special Interest	33	0	67	0	*3*	67	0	0	0	*3*	67	0	33	0	*3*
Patent	0	0	0	100	*1*	0	0	0	0	*0*	0	0	0	0	*0*
Policy/Practice	0	0	0	0	*0*	0	0	0	0	*0*	0	0	0	0	*0*
Publication	40	20	35	25	*20*	16	32	52	10	*31*	42	35	54	19	*26*
Report	0	0	0	0	*0*	0	0	0	0	*0*	0	0	0	0	*0*
Request for Information	0	100	0	0	*1*	50	50	0	0	*2*	0	100	0	0	*1*
Research Project	45	37	29	16	*76*	43	36	28	14	*103*	38	43	27	14	*107*
Research Resource	45	36	45	9	*11*	43	36	36	7	*14*	47	40	33	7	*15*
Strategic Plan	0	0	100	0	*1*	50	50	100	50	*2*	0	0	100	0	*1*
Webinar	100	67	33	67	*3*	100	40	40	40	*5*	67	33	50	33	*6*
TOTAL	39	30	38	19	*160*	37	30	37	14	*228*	40	35	36	15	*220*

0–9%	10–25%	26–40%	41–55%	56–70%	71–100%

Cross-cutting research areas are represented across various deliverables. **Table 4** shows the percentage of each type of deliverable mapping to four cross-cutting areas over FY20–22. Data science has a strong representation across all 3 years, with health of women and rigor and reproducibility also being represented by at least half of the different types of deliverables. Training and workforce development has the lowest number of deliverables, as reflected in the average percentage of deliverables per year being just 10 percent.

Table 4. Percentage of each deliverable mapping to cross-cutting areas from FY20–22

	2020						2021						2022					
	Health Disparities	Health of Women	Rigor and Reproducibility	Data Science	Training and Workforce	*Total # of deliverables*	Health Disparities	Health of Women	Rigor and Reproducibility	Data Science	Training and Workforce	*Total # of deliverables*	Health Disparities	Health of Women	Rigor and Reproducibility	Data Science	Training and Workforce	*Total # of deliverables*
Clinical Study	0	17	17	67	0	*6*	0	17	17	67	0	*6*	0	17	17	67	0	*6*
Clinical Trial	45	9	36	9	0	*11*	45	9	36	9	9	*11*	38	15	31	15	15	*13*
Committee/ Workgroup/ Task Force	10	20	20	10	20	*10*	10	30	20	10	10	*10*	9	27	27	9	9	*11*
Conference/ Meeting/ Workshop	33	33	0	33	33	*3*	20	20	0	20	10	*10*	11	22	67	22	22	*9*
Notice of Funding Opportunity	0	13	0	50	13	*8*	23	23	14	77	14	*22*	6	13	0	75	13	*16*
Guideline	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*
Initiative	83	33	50	50	33	*6*	78	44	44	44	22	*9*	83	33	50	33	33	*6*
Notice of Special Interest	67	67	0	33	0	*3*	0	0	0	67	0	*3*	67	33	33	33	0	*3*
Patent	0	0	0	100	0	*1*	0	0	0	0	0	*0*	0	0	0	0	0	*0*
Policy/ Practice	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*
Publication	25	20	5	40	15	*20*	13	13	10	16	3	*31*	23	23	12	23	15	*26*
Report	0	0	0	0	0	*0*	0	0	0	0	0	*0*	0	0	0	0	0	*0*
Request for Information	0	0	0	100	0	*1*	0	0	0	50	0	*2*	0	0	0	100	0	*1*
Research Project	29	24	38	30	8	*76*	30	27	0	37	10	*103*	28	29	36	23	6	*107*
Research Resource	9	9	55	64	9	*11*	21	7	50	71	0	*14*	13	7	40	60	13	*15*
Strategic Plan	100	0	0	0	0	*1*	50	50	50	50	50	*2*	100	100	100	100	0	*1*
Webinar	33	33	67	67	67	*3*	20	60	80	40	20	*5*	50	17	50	33	17	*6*
TOTAL	28	21	30	36	11	*160*	26	23	13	39	9	*228*	26	24	32	31	10	*220*

0–9%	10–25%	26–40%	41–55%	56–70%	71–100%

A full breakdown of how each category of deliverable maps to each objective during FY20–22 is shown in Appendix B.

Illustrative Examples of Nutrition Research from Institutes, Centers, and Offices

In total, 31 ICOs submitted deliverables that are helping to fulfill the goals of the SPNNR. To highlight the wide range of topics covered by these clinical trials, research projects, initiatives, notices of funding opportunities, task forces, and other types of deliverables, illustrative examples from 24 of the ICOs are listed below.

Environmental influences on Child Health Outcomes (ECHO)

Association Between Meeting Physical Activity, Sleep, and Dietary Guidelines and Cardiometabolic Risk Factors and Adiposity in Adolescents

This ECHO-funded study assessed whether meeting national guidelines for physical activity, sleep, and diet affected cardiometabolic risk factors and adiposity in adolescent populations, ages 10 to 16 years. The study showed that meeting the physical activity guideline or multiple guidelines lowered cardiometabolic risk factors and adiposity. However, fewer than half of the adolescent participants met the physical activity and dietary guidelines. Therefore, strategies that improve multiple behaviors in adolescents may provide the most benefit for long-term health.

Fogarty International Center

Childhood Obesity Prevention Across Borders: The Promise of U.S.–Latin American Research Collaboration

The Cross Border Collaboration Awards sponsored travel, conference, and capacity-building collaborative contracts intended to promote new collaborations between U.S. and Latin American investigators who perform high-quality childhood obesity research. The program sponsored 13 initiatives, 11 of which have a specific nutrition component.

National Center for Advancing Translational Sciences

AI Data Engineering and ML (AIDE-ML) Center

The United States Military Academy (USMA) AI Data Engineering and ML (AIDE-ML) Center is working to advance nutrition for precision health by developing and utilizing the Data Distiller for Precision Nutrition. This tool collapses and distills nutrition-relevant data to create data sets that are AI ready, allowing more efficient analysis and potential combination of multiple data sets to increase the power of experiments. Additionally, the Center is working to create better data infrastructure and resources that will support the development of novel tools for data analysis.

National Center for Complementary and Integrative Health (NCCIH)

Multiomic Signatures of Microbial Metabolites Following Prebiotic Fiber Supplementation

This NCCIH-funded project is helping to identify how prebiotic fiber—a dietary component that helps to foster growth and activity of the beneficial microorganisms in the gut called the microbiome—exerts its beneficial effects. Using a mix of techniques, the researchers are working to understand what metabolites are produced by the microbiome in response to prebiotic fiber and what downstream effects this has on health. The findings may suggest strategies for personalized dietary interventions.

National Cancer Institute (NCI)

Healthy Eating Index

The Healthy Eating Index (HEI) is a measure of diet quality that can be used to assess how well a set of foods aligns with recommendations and dietary patterns published in the Dietary Guidelines for Americans (DGAs). The HEI is a scoring

metric that can help determine overall diet quality, and it is a valuable tool for epidemiologic and economic research. In collaboration with the U.S. Department of Agriculture, NCI works to revise the HEI based on updates to the DGAs.

National Heart, Lung, and Blood Institute (NHLBI)

Chrononutrition: Elucidating the Role of Circadian Biology and Meal Timing in Cardiometabolic Health

This virtual workshop hosted by NHLBI examined the interface between circadian rhythms and nutrition in the pathophysiology and management of heart, lung, blood, and sleep diseases and conditions. The discussion highlighted emerging discoveries linking circadian and nutrition science and identified opportunities to apply these discoveries to medical practice to improve disease prevention, treatment, and health outcomes.

National Human Genome Research Institute (NHGRI)

Research on Genomic and Environmental Interactions (GxE), Including the Interactions of Genes and Diet and Nutrition

These 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. Two research groups, including one of NHGRI's Centers of Excellence in Genomic Science, are studying diet and its relationship to metabolic disease and developing novel statistical methods to measure gene–environment interactions contributing to metabolic disease. In addition, NHGRI-funded researchers are exploring the mechanisms by which genes and hormones interact to affect women's eating behavior in a longitudinal study on eating disorders.

National Institute on Aging (NIA)

The Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) Diet Is Associated with Physical Function and Grip Strength in Older Men and Women

This NIA-funded research demonstrates that adherence to the MIND dietary pattern—a diet that emphasizes foods and nutrients shown to benefit cognitive health and dementia prevention, such as berries, green leafy vegetables, and fish—was associated with lower odds of physical function impairment and decline and better muscle strength. This suggests that the MIND dietary pattern may mitigate a decline in physical function in older adults and could help with maintaining independence and promoting healthy aging.

National Institute of Allergy and Infectious Diseases (NIAID)

Early Peanut Introduction: Translation to Clinical Practice

Researchers are working to understand the development of food allergies in young children and how to prevent them. Recent studies demonstrate that early introduction of peanuts can prevent peanut allergy in more than half of infants. However, more research is needed to understand whether screening is needed prior to early peanut introduction, how this screening should be done, and what quantity of peanut exposure is needed to prevent allergy. An NIAID-funded clinical trial is attempting to answer these questions and improve the diagnosis and prevention of peanut allergies at an early age.

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)

Vitamin D and Fish Oil for Autoimmune Disease, Inflammation and Knee Pain

This NIAMS-funded study is examining the effects of vitamin D and omega-3 fatty acid supplementation on the incidence of autoimmune diseases. It builds on previous NIH-funded work that found these supplements help to reduce the risk of cancer, heart disease, and stroke in people who do not have a prior history of these illnesses.

***Eunice Kennedy Shriver* National Institute of Child Health and Human Development (NICHD)**

Eating Behavior from Pregnancy Through Early Childhood (PEAS and SPROUTS Studies)

The Pregnancy Eating Attributes Study (PEAS) is an observational cohort study with the overarching goal of identifying neurobehavioral and environmental determinants of excessive gestational weight gain and postpartum weight retention to inform best practices for supporting optimal diet quality and weight management, leading to improved health trajectories for both mother and child. The SPROUTS study follows this cohort through early childhood, enabling the investigation of how prenatal and infant exposures influence the development of child reward-related eating behaviors, diet, and growth.

National Institute on Drug Abuse (NIDA)

Examining Highly Palatable Food Consumption upon Initiation of Methadone Maintenance Treatment

This NIDA-funded study is assessing whether consumption of highly palatable foods is beneficial or detrimental to the risk for returning to illicit opioid use in patients who recently initiated methadone to treat opioid use disorder (OUD). This research could create more effective interventions to extend recovery and decrease the public health impact of OUD.

National Institute on Deafness and Other Communication Disorders (NIDCD)

Downshifting Sweet Preference and Added Sugar Intake During Snacking Among Young Children: A Randomized Controlled Trial

NIDCD supported a clinical trial to test whether preschoolers prefer lower-sugar snacks after a 4-month intervention that gradually reduced sugar exposure. The knowledge gained may lead to targeted strategies to reduce added sugar intake in children, which will have widespread health implications for the prevention of obesity, dental caries, and cardiovascular disease in future generations.

National Institute of Dental and Craniofacial Research (NIDCR)

Photo-Enhanced Messaging to Address Dietary Sugars as a Common Risk Factor for Chronic Disease

Tooth decay is a common oral disease particularly prevalent in underserved populations, for which added sugar consumption increases the risk. NIDCR-funded researchers are developing an innovative technique called PhotoVoice to develop picture-enhanced messaging to identify barriers and facilitators to reducing the consumption of sugar-sweetened beverages and foods among adult residents in public housing. These investigators will use their results to create strategies for targeted reduction of dietary sugar in a public housing population.

National Institute of Diabetes and Digestive and Kidney Diseases

Nutrition Obesity Research Centers

The Nutrition Obesity Research Centers (NORC) program is designed to support and enhance the national research effort in nutrition and obesity by enhancing the efficiency, productivity, effectiveness, and multidisciplinary nature of this research. Eleven NORCs throughout the country provide research services, pilot grant funding, and support for early stage investigators and those new to the nutrition and obesity research space.

National Institute of Environmental Health Sciences (NIEHS)

Can Nutrition Modify the Impact of Environmental Exposures on Autism Spectrum Disorder?

The NIEHS Division of Extramural Research and Training Autism and Environment Program hosted a workshop titled “Can Nutrition Modify the Impact of Environmental Exposures on Autism Spectrum Disorder?” The workshop focused on the possible role of maternal diet and nutrition in mitigating the effects of environmental risks relevant to neurodevelopmental

disorders like autism spectrum disorder. Environmental health scientists and nutrition researchers discussed a variety of topics, including mechanisms linking maternal nutrition and neurodevelopment, modifiers of environmental exposure, and methods for studying complex nutrient effects.

National Institute of General Medical Sciences (NIGMS)

Integrative Center for Precision Nutrition and Human Health

This NIGMS-funded Integrative Center for Precision Nutrition and Human Health at the University of Hawai'i at Manoa aims to promote better nutrition and health throughout the community, state, and beyond. The Center focuses on precision nutrition, a new component of medicine that considers differences in genes, environment, culture, and customs that affect how nutrients are absorbed and converted to energy, resulting in widely varying dietary and nutrient requirements.

National Institute of Mental Health (NIMH)

Leveraging Social Media to Identify and Connect Teens with Eating Disorders to a Mobile Guided Self-Help Mobile Intervention

These NIMH-supported researchers aimed to improve upon existing treatments for teens with eating disorders to prevent long-term consequences of these diseases by leveraging a mobile self-help application to connect individuals with eating disorders to mental health services. The research explored the use of app-based personalized coaching, interactive sessions, rewards for continued use, and social networking features to help reduce eating disorder symptoms, improve quality of life, and increase uptake of care.

National Institute on Minority Health and Health Disparities (NIMHD)

Reduction of Risk Factors for Obesity and Linked Chronic Diseases in Native American Employees of the Twin Arrows Casino

This NIMHD-funded research is assessing the effectiveness of a culturally relevant, micronutrient-dense, plant-rich dietary program on risk factors for obesity and related diseases in a cohort of American Indians. The study is examining whether the diet can improve body weight, waist size, and indicators of heart disease and diabetes, as well as anxiety, stress, and mood. The results may inform how to prevent chronic illness in certain populations.

National Institute of Neurological Disorders and Stroke (NINDS)

Dissecting Microbiota-Gut-Brain Interactions for the Anti-Seizure Effects of the Ketogenic Diet

This NINDS-funded research is exploring whether the microorganisms in the gut, termed the microbiome, play a role in mediating the anti-seizure effects of a ketogenic diet. Findings from these studies will advance our understanding of how the microbiome impacts health and disease, including the role it plays in mediating effects of certain dietary patterns on health outcomes. They will also inform the development of microbe-based therapeutics for disorders of the nervous system.

National Library of Medicine (NLM)

Harnessing Patient Generated Data to Find Causes and Effects of Diet in Pregnancy

NLM is generating better methods for continually assessing disease risk and gaining insight into the contribution of diet to disease risk over time using patient-generated health data, such as continuous glucose monitoring data, activity data, and food log data. Initial studies are using these methods to explore which dietary factors might increase the risk for

gestational diabetes mellitus in pregnant women; future studies using these methods can focus on other time-restricted and chronic conditions.

Office of Dietary Supplements (ODS)

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

The CARBON Program—initiated by ODS in partnership with NCCIH—promotes collaborative, transdisciplinary research on the safety, effectiveness, and mechanisms of action of botanical dietary supplements that have a high potential to benefit human health and to support the development of methods and resources that will enhance the progress of this research. All the Centers are jointly funded by ODS and NCCIH, with additional funding from NIA for the 2020–2025 project period.

Office of Nutrition Research

Advanced Training in Artificial Intelligence for Precision Nutrition Science Research (AIPrN) Institutional Research Training Programs (T32)

The ONR-initiated AIPrN Program focuses on supporting institutional training programs that facilitate the integration of precision nutrition, AI, machine learning, systems biology, systems science, big data, and computational analytics. The goal of the program is to build a future workforce that will be able to use growing data resources to address complex biomedical challenges in nutrition science and develop innovative solutions to combat chronic nutrition- and diet-related diseases.

Office of Strategic Coordination (OSC)

NIH Common Fund's Nutrition for Precision Health, Powered by the All of Us Research Program

NIH is supporting the single largest national investment in nutrition research, the NIH Common Fund's *Nutrition for Precision Health, powered by the All of Us Research Program*. Approximately 8,000 participants will be enrolled in the study; the goal of the study is to use AI to develop algorithms to predict individual responses to food and dietary patterns that can subsequently inform personalized approaches to health.

Conclusions and Future Opportunities

Within the first 3 years of the SPNNR, NIH ICOs have made tremendous strides toward increasing our understanding of the unique nutritional needs of individuals based on genetics, dietary habits and eating patterns, circadian rhythms, health status, socioeconomic and psychosocial characteristics, food environments, physical activity, and the microbiome. This progress, guided by ONR, has materialized in the form of clinical studies and trials; meetings, workshops, and task forces that bring together a wide array of expertise; increased funding notices; research resources; research projects and their resulting publications; and additional outputs and opportunities.

While progress has been made toward meeting the four strategic goals of the SPNNR, opportunities remain for expansion of the NIH nutrition portfolio. The above analyses show that while Strategic Goals 1, 2, and 3 are represented by about 35 percent of the deliverables, Strategic Goal 4 has less representation. Efforts are underway to build opportunities related to this goal, including a previously approved concept for the NIH Food is Medicine Centers of Excellence.

Strategic Goals 1, 2, and 3 have more representation, but the objectives that are identified within these strategic goals are not evenly distributed. Therefore, within Strategic Goal 1, special emphasis can be given to enhancing opportunities that address bioinformatic gaps in nutrition-related genes and pathways, improving the understanding of sensory nutrition and ingestive behaviors, and creating tools for microbiome and precision nutrition. For Strategic Goal 2, opportunities can be

supported that advance methods for dietary pattern analysis, determine the mechanisms of interindividual variability in the response to food-based dietary patterns, determine the health benefits and mechanisms of time-based dietary patterns, and discover and validate prognostic chronic disease biomarkers. For Strategic Goal 3, future work can focus on increasing knowledge of human milk composition and the translational roles of its components and developing predictive epigenetic tools. Some efforts already are addressing these objectives, including the Human Milk Composition Initiative (HMCI), which is a cross-agency group led by NICHD to support nutrition and dietary monitoring; guidelines; education; and other policies, programs, and regulations in maternal and child health. The HMCI coordinates development of human milk composition data in the United States and Canada for use by federal policy, program, and other interested parties. For the cross-cutting areas outlined in the SPNNR, future opportunities also exist to enhance workforce development and training.

Since the inception of the SPNNR, interest in opportunities related to furthering our understanding of individual nutritional needs and variability in responses to nutritional interventions has increased tremendously. The concepts of "precision nutrition" and "food is medicine" have received burgeoning interest from the research, clinical, and patient communities. Furthermore, a renewed focus on prevention and early treatment of chronic conditions offers a major role for nutrition research to address complex health issues and answer fundamental questions about how, what, and when we eat and how that affects us over the entire lifespan.

Under the guidance of ONR, NIH is poised to continue its investment in nutrition research and opportunities to ensure that we understand how nutrition affects all aspects of our health to continue to support the well-being of all Americans.

Appendix A: Descriptions of Deliverable Types Detailed Within the Report

Deliverable	Description
Clinical Study	Research involving human participants
Clinical Trial	Research study where one or more human subjects are prospectively assigned to receive interventions that are evaluated for health-related outcomes
Committee/Workgroup/Task Force	Group of people appointed for a specific function
Conference/Meeting/Workshop	Any seminar, workshop, symposium, or organized meeting where individuals exchange information, in person or virtual
Notice of Funding Opportunity	A publicly available document to make it known that a federal agency intends to award grants or cooperative agreements
Guideline	Statements to assist practitioners and patients in deciding about appropriate health care for specific clinical concerns
Initiative	Request for application (RFA), request for proposal (RFP), or program announcement (PA) stating interest in receiving applications in a given area
Notice of Special Interest	Notice in the NIH Guide for Grants and Contracts that highlights a specific topic of interest
Patent	Document issued by the U.S. Patent and Trademark Office giving the owner a right to exclude others from making a product
Policy/Practice	An adopted or proposed course or principle of action; a customary, habitual, or expected procedure
Publication	A peer-reviewed scientific document, poster, manuscript, or abstract
Report	Describes process, progress, or results of research; may include recommendations
Request for Information	Provides a chance for government, community stakeholders, and human services providers to share challenges and best practices
Research Project	Provision of funds to an organization to carry out a project or activity
Research Resource	Data analysis tools, data or biospecimen repositories, reporting tools, or other resources that help conduct research
Strategic Plan	An outline of an ICO's vision for biomedical research direction, capacity, and stewardship
Webinar	Virtual event(s) to learn more about a topic

Appendix B: Mapping of Deliverables to Goals/ Objectives

Tables 5, 6, and 7 provide year-by-year breakdowns of how each category of deliverable mapped to the goals and objectives of the SPNNR between FY20 and FY22.

Table 5. Percentage of deliverables mapping to goals and objectives from FY20

	Goal 1							Goal 2							Goal 3						Goal 4			
	Total	1-1	1-2	1-3	1-4	1-5	1-6	Total	2-1	2-2	2-3	2-4	2-5	2-6	Total	3-1	3-2	3-3	3-4	3-5	Total	4-1	4-2	4-3
Clinical Study	17	0	0	17	0	0	0	0	0	0	0	0	0	0	33	17	0	33	0	0	50	50	0	0
Clinical Trial	9	0	9	0	0	0	0	27	0	9	0	0	0	18	64	0	0	18	0	45	27	27	0	0
Committee/ Workgroup/ Task Force	30	10	10	20	0	10	10	10	0	0	0	0	0	10	60	20	50	30	0	10	10	10	0	0
Conference/ Meeting/ Workshop	67	0	33	0	33	0	0	0	0	0	0	0	0	0	33	0	0	33	0	0	67	33	33	0
Notice of Funding Opportunity	25	0	0	0	0	25	0	25	0	0	25	0	0	0	50	38	13	38	0	25	13	13	0	0
Guideline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initiative	33	0	17	0	0	0	17	50	0	33	0	0	0	17	50	0	0	33	17	0	0	0	0	0
Notice of Special Interest	33	0	0	0	0	33	0	0	0	0	0	0	0	0	67	67	0	67	0	0	0	0	0	0
Patent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	0	0
Policy/ Practice	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Publication	40	5	20	20	0	5	0	20	0	5	5	5	5	10	35	5	10	10	0	15	25	25	5	5
Report	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Request for Information	0	0	0	0	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
Research Project	45	13	4	30	20	5	5	37	4	7	4	12	0	22	29	4	5	14	4	13	16	16	11	7
Research Resource	45	0	0	0	0	9	36	36	27	0	0	9	9	9	45	27	0	18	0	18	9	9	0	0
Strategic Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	0	0	0	0	0	0
Webinar	100	33	33	67	33	33	67	67	33	33	67	33	33	33	33	33	33	33	33	33	67	33	67	33
Totals	39	8	8	20	11	7	8	30	4	6	5	8	2	16	38	11	9	20	3	15	19	18	8	4

0–9%	10–25%	26–40%	41–55%	56–70%	71–100%

Table 6. Percentage of deliverables mapping to goals and objectives from FY21

	Goal 1							Goal 2							Goal 3						Goal 4			
	Total	1-1	1-2	1-3	1-4	1-5	1-6	Total	2-1	2-2	2-3	2-4	2-5	2-6	Total	3-1	3-2	3-3	3-4	3-5	Total	4-1	4-2	4-3
Clinical Study	17	0	0	17	0	0	0	0	0	0	0	0	0	0	33	17	0	33	0	0	50	50	0	0
Clinical Trial	9	0	9	0	0	0	0	27	0	9	0	0	0	18	64	0	0	18	0	45	27	27	0	0
Committee/ Workgroup/ Task Force	30	10	10	20	0	10	10	10	0	0	0	0	0	10	60	20	50	30	0	10	10	10	0	0
Conference/ Meeting/ Workshop	10	0	0	10	0	0	0	10	0	0	0	0	0	10	50	10	20	20	0	0	10	0	10	0
Notice of Funding Opportunity	55	0	5	9	5	18	23	18	5	5	5	5	5	9	27	18	9	23	0	14	9	9	0	9
Guideline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initiative	33	0	11	0	0	0	22	33	0	22	0	0	0	11	56	11	11	33	11	0	0	0	0	0
Notice of Special Interest	67	0	0	0	0	33	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Patent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Policy/ Practice	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Publication	16	0	0	10	0	0	6	32	10	6	6	0	0	10	52	19	0	3	0	29	10	10	0	0
Report	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Request for Information	50	50	0	0	0	0	0	50	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0
Research Project	43	10	9	25	14	4	5	36	4	6	3	8	0	24	28	4	4	13	3	14	14	12	9	6
Research Resource	43	0	0	0	0	7	36	36	21	0	7	7	7	7	36	21	0	14	0	14	7	7	0	0
Strategic Plan	50	50	0	50	0	50	0	50	50	50	0	50	0	50	100	50	0	100	0	0	50	50	50	50
Webinar	100	20	20	40	20	20	80	40	20	20	40	20	20	20	40	20	20	40	20	20	40	20	40	20
Totals	37	6	6	17	7	6	11	30	6	6	4	5	1	17	37	11	7	16	2	15	14	12	6	4

0–9%	10–25%	26–40%	41–55%	56–70%	71–100%

Table 7. Percentage of deliverables mapping to goals and objectives from FY22

	Goal 1							Goal 2							Goal 3						Goal 4			
	Total	1-1	1-2	1-3	1-4	1-5	1-6	Total	2-1	2-2	2-3	2-4	2-5	2-6	Total	3-1	3-2	3-3	3-4	3-5	Total	4-1	4-2	4-3
Clinical Study	17	0	0	17	0	0	0	0	0	0	0	0	0	0	33	17	0	33	0	0	50	50	0	0
Clinical Trial	15	0	15	0	0	0	0	46	0	23	8	0	0	15	62	0	0	23	0	38	15	15	0	0
Committee/ Workgroup/ Task Force	36	9	9	18	0	9	18	9	0	0	0	0	0	9	55	18	45	27	0	9	9	9	0	0
Conference/ Meeting/ Workshop	44	0	0	11	11	11	11	22	0	0	11	0	0	11	33	22	11	22	0	11	56	11	33	22
Notice of Funding Opportunity	63	0	6	6	0	25	25	6	0	0	0	0	0	6	25	13	13	13	0	13	0	0	0	0
Guideline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Initiative	33	0	17	0	0	0	17	50	0	33	0	0	0	17	50	0	0	33	17	0	0	0	0	0
Notice of Special Interest	67	0	0	0	0	33	33	0	0	0	0	0	0	0	33	0	0	33	0	0	0	0	0	0
Patent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Policy/ Practice	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Publication	42	0	15	12	8	0	8	35	12	15	8	8	8	8	54	8	0	4	0	42	19	15	12	8
Reports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Request for Information	0	0	0	0	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
Research Project	38	11	4	24	17	6	5	43	4	7	3	10	2	29	27	5	5	10	3	13	14	14	8	6
Research Resource	47	0	0	0	0	20	27	40	20	0	0	20	20	20	33	20	0	13	0	13	7	7	0	0
Strategic Plan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	0	0	0	100	0	0	0	0
Webinar	67	17	33	33	17	17	33	33	17	17	33	17	17	17	50	33	17	17	17	33	33	17	33	17
Totals	40	6	7	16	10	8	10	35	5	8	4	8	4	20	36	9	6	14	2	18	15	13	8	5

0–9%	10–25%	26–40%	41–55%	56–70%	71–100%

Appendix C: Acknowledgments

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