

Agricultural Research Service  
National Program 107  
Human Nutrition  
2023 National Program Annual Report

This report synthesizes research and accomplishments from scientists and their support staff working in USDA Agricultural Research Service (ARS) National Program 107 (NP107), Human Nutrition from October 1, 2022, through September 30, 2023.

## Mission

The mission of USDA ARS NP 107, Human Nutrition, is to define the role of food and its components in optimizing health throughout the life cycle for all Americans by conducting high national priority research.

## Vision

The vision for the program is that well-nourished Americans make health-promoting diet choices based on scientific evidence.

## Relationship to USDA and ARS Strategic Plans and Goals

NP 107 addresses high-priority problems of national importance as outlined in ARS Program Area 1, Strategic Goal 4: Make Safe, Nutritious Food Available to All Americans; Objective 4.2: Encourage healthy dietary choices through data-driven, flexible, customer-focused approaches of the [ARS Strategic Plan 2023-2026](#).

It also addresses the [USDA Strategic Plan for Fiscal Years 2022-2026](#), Goal 4: Providing All Americans Safe, Nutritious Food; Objective 4.2- Encourage Healthy Dietary Choices Through Data-Driven, Flexible, Customer-Focused Approaches.

This research also addresses the [USDA Science and Research Strategy 2023-2026](#), Priority 3: Bolstering Nutrition Security and Health, and the [USDA Science Blueprint A Roadmap for USDA Science from 2020 to 2025](#), Theme 3: Food and Nutrition Translation.

## Introduction

As nutrient requirements to prevent deficiency diseases have been mostly defined, nutrition research now needs to address optimization of health and prevention of chronic diseases. NP 107 is well-positioned to work on this as three of the six Human Nutrition Research Centers have Congressionally mandated missions of studying nutrition and its health effects during different phases of the lifecycle. New functions of nutrients continue to be discovered as do new metabolic pathways, including microRNAs and the role of intestinal bacteria in regulating metabolism and preventing disease.

Human nutrition research studies nutrient composition of foods, what people consume, methods to improve precision and accuracy of those activities, nutrient requirements for all age groups including pregnant and lactating women, how nutrition can maintain health throughout the lifespan from conception to old age and preventing the development of chronic diseases including obesity. Unique aspects of the ARS Human Nutrition Program are its work with crop and animal production researchers to discern how changes in farming conditions and practices affect the nutrient content of the American diet; compilation of food composition analysis and its dissemination in databases; and conduct of a nationally representative diet survey of how much and what foods Americans eat. This information is

needed by regulatory agencies, health agencies, and health professionals to understand the nutritional status of the American population and its multiple subgroups.

Defining features of NP 107 research include an emphasis on food-based approaches to improving health, the capacity of six, internationally-recognized Human Nutrition Research Centers with the core capability for long-term, multi-disciplinary, translational research in high priority areas to improve the Nation's health along with the availability of premier scientists, state-of-the-science equipment and facilities for human research across the lifecycle. Unique national resources that are part of NP 107 include the National Nutrient Data Laboratory, the Food Surveys Research Group that conducts the "What We Eat in America" portion of National Health and Nutrition Examination Survey (NHANES), and a laboratory that develops and improves methods for food analysis. Partnerships with other federal, non-profit, and industry groups allow ARS to leverage funds and build upon common research goals.

There are five research components in the [Human Nutrition Action Plan](#) for 2019-2024:

- Linking Agricultural Practices and Beneficial Health Outcomes
- Monitoring Food Composition and Nutrient Intake of the Nation
- Scientific Basis for Dietary Guidance
- Prevention of Obesity and Obesity-Related Diseases
- Life Stage Nutrition and Metabolism

## Component 2: Monitoring Food Composition and Nutrient Intake of the Nation

Monitoring food composition and nutrient intake of Americans is foundational for promulgating public policy, developing dietary guidance, conducting nutrition research and making decisions regarding food production. The food choices Americans make are dynamic and reflect an everchanging U.S. food supply and population, and vigilance, adaptability, and sophistication are needed to stay at the forefront of this endeavor.

### Problem Statement 2B: Determine Food Consumption and Dietary Patterns of Americans

"What We Eat in America (WWEIA), NHANES," conducted in partnership with the Department of Health and Human Service's National Center for Health Statistics, is the only nationally representative American dietary survey. The resulting data are used by a broad array of national and international government agencies, food industries and researchers for development of public policy and dietary guidance, guiding food product development and assessment, and for scientific research. ARS will continue to collect, disseminate, and evaluate the nutritional data. However, changing demographics and consumer choices, as well as new uses of, and demands for, data make it essential that ARS adapt new and improved methodologies and technologies for data collection, processing, quality control and dissemination.

#### *Accomplishments:*

- **Release of Food Patterns Equivalents Database for Use with WWEIA, NHANES 2017-March 2020.** ARS researchers in Beltsville, Maryland, developed the Food Patterns Equivalents Database (FPED), which provides an alternative to using the Dietary Guidelines for Americans for assessing individual diets. Three sets of FPED tables posted online summarize national dietary survey data conducted from 2017 to March 2020 for food and beverage intakes across the 37 Food Pattern components for 23 age-gender and socio-economic groups. These estimates provide unique data to evaluate food and beverage intakes of Americans, compared to 2020-2025 Dietary Guidelines for Americans recommendations. The FPED for Use with WWEIA, NHANES 2017-March 2020, which converts foods reported in the 2017-March 2020 survey years as well as the Methodology and User Guide for FPED, were also released online and can be accessed at [www.ars.usda.gov/nea/bhnrc/fsrg](http://www.ars.usda.gov/nea/bhnrc/fsrg). (NP 107, C2, PSB, Project No. 8040-53000-020-000D)

Database: [FPED data tables : USDA ARS](#)

- **Technological advances to noninvasively determine changes in vegetable consumption.** Much research has been devoted increasing the consumption of fruits and vegetables (FV), but accurately assessing changes in FV consumption is difficult. Plant carotenoids that give plants their bright yellow, orange, and red color are a FV consumption biomarker that circulate in the blood and are deposited in the skin. Recent technological advances have produced relatively simple analyzers that use pressure-mediated reflection spectroscopy (RS) to measure skin carotenoid levels. ARS scientists in Grand Forks, North Dakota, tested the capacity of RS to detect changes in skin carotenoids in response to different levels of carotenoids intake. Healthy adults drank either water or three different amounts of vegetable juice every day for 8 weeks and skin carotenoids levels were measured weekly. Results indicate that RS can be used to detect changes in the consumption of carotenoid-rich FV, but that consumption levels and how long the FV are consumed are important factors to be considered when using this technology. These results provide essential knowledge on using RS in interventional or epidemiological research to noninvasively determine carotenoid intake. (NP 107, C2, PSB, Project No. 3062-51000-057-000D)

Publication: Casperson, S.L., Jahns, L.A., Larson, K.J., Hess, J.M., Palmer, D., Roemmich, J.N. 2023. Sensitivity of pressure-mediated reflection spectroscopy to detect dose-dependent changes in skin carotenoids: A randomized controlled trial. *Journal of Nutrition*. 153(2):588-597.

### Component 3: Scientific Basis for Dietary Guidance

Dietary Reference Intake values for individual nutrients and the Dietary Guidelines for Americans form the basis for federal, state, and local food and nutrition policies. These are used by researchers, health professionals, the food industry, and individual Americans. Strong scientific evidence is needed to provide accurate dietary guidance. Generating this evidence is challenging due to changes in the demographics of the U.S. population, changes in the food supply, changes in how and where food is prepared and consumed, inter-individual variability in responses to dietary differences, and environmental influences. This work is also challenged by publication of sometimes contradictory data regarding specific foods, micro/macronutrients, and disease prevention. There is accumulating evidence that components beyond recognized nutrients contribute to optimal health and recommendations need to be considered for these substances. ARS scientists will utilize population-based and clinical studies to provide evidence for dietary guidance and will utilize animal and cellular studies to examine specific mechanisms.

#### Problem Statement 3A: Improve the Scientific Basis for Updating National Dietary Standards and Guidelines

Our understanding of the physiologic processes underlying healthy development and aging and the prevention of disease is constantly expanding. We are faced with the need to accumulate new information relating how diets, foods, and bioactive food components, and physical activity influence these processes. There is increasing appreciation of individual genetic and epigenetic differences that influence how dietary intake and physical activity affect health. Additionally, there is increasing evidence that some substances may exert their effects on health indirectly through alterations of the microbiome.

#### *Accomplishments:*

- **Inadequate vitamin K intakes in the elderly may affect dementia risks.** As part of the Rush Memory and Aging Project, ARS-funded researchers in Boston, Massachusetts, demonstrated that higher postmortem brain levels of a vitamin K metabolite were associated with better cognitive function prior to death. They also found higher brain vitamin K concentrations were associated with lower odds of dementia or mild cognitive impairment. These findings provide

new and compelling evidence implicating vitamin K in neuropathology underlying cognitive decline and dementia. (NP 107, 3, PSA, Project No. 8050-51000-099-000D)

Publication: Booth SL, Shea MK, Barger K, Leurgans SE, James BD, Holland TM, Agarwal P, Fu X, Wang F, Matuszek G, and Scheider JA. Association of vitamin K with cognitive decline and neuropathology in community-dwelling older persons, *Alzheimers Dement*. 2022; 20:8: e12255.

- **Dietary fat type influences cardiovascular disease risks.** Cardiovascular disease is the leading cause of death in the United States. Some, but not all, studies have shown that very long chain omega-3 fatty acid supplements can reduce cardiovascular disease risk. There are two major very long chain omega-3 fatty acids, eicosapentaenoic acid (EHA) and docosahexaenoic acid (DHA), and it is unclear if they act differently in preventing cardiovascular disease or if there are sex-specific responses to supplementation. ARS-funded researchers in Boston, Massachusetts, compared how EHA and DHA supplementation affects an immune cell that is actively involved in cardiovascular disease and found that both EHA and DHA reduced activation of these immune cells. However, compared to DHA, EHA supplementation reduced inflammation pathways in men only, while other responses were noted in women only. These findings suggest EHA and DHA effects can be sex-dependent, which may contribute to conflicting results from previous clinical trials assessing their impact on cardiovascular disease risks. (NP 107, C3, PSA, Project No. 8050-51000-103-000D)

Publication: So, J., Asztalos, B.F., Horvath, K., Lamon-Fava, S. 2022. Ethyl EPA and ethyl DHA cause similar and differential changes in plasma lipid concentrations and lipid metabolism in subjects with low-grade chronic inflammation. *Journal of Clinical Lipidology*.  
<https://doi.org/10.1016/j.jacl.2022.10.002>.

### Problem Statement 3B: Identify Roles of Food, Food Components and Physical Activity in Promoting Health and Preventing Disease

Diet-related chronic diseases such as type 2 diabetes, cardiovascular disease, osteoporosis, and cancer are major public health concerns in the United States. In addition, age-related declines in visual function, cognition, immunity, and the musculoskeletal system may all be amenable to nutritional modulation. Population-based research links dietary patterns, the intakes of specific nutrients or other food components and physical activity with health maintenance and decreased risk of disease. However, rigorously-designed evaluations of the relationships and analysis of the physiologic processes underlying these effects are often lacking or are equivocal. Advances in technology have created new tools and opportunities that afford scientists a hitherto unprecedented ability to discern the mechanisms by which these factors promote health and prevent disease. Advanced techniques in genomics, proteomics and metabolomics, as well as recently discovered physiologic relationships such as host-gut microbiome interactions or inter-organ microRNA-based signaling provide ARS scientists with potentially fruitful, high-impact lines of research.

#### *Accomplishments:*

- **Diverse dietary monosaccharides associated with a healthier gut.** The human gut microbiome influences health, but more information is needed about dietary factors that support a healthy microbiome. ARS scientists in Davis, California, mapped dietary data of a human cohort to the Davis Food Glyclopedia to determine the level of 10 different sugar monomers, or monosaccharides, in the diets of healthy U.S. adults. A higher dietary diversity of monosaccharides was associated with greater gut microbiome diversity and lower gastrointestinal inflammation. Specific food sources were enriched for individual monosaccharides that were associated with specific gut microbes. These results suggest that diets could be tailored to include foods that are rich sources of specific monosaccharides to support the growth of specific gut microbes. This approach, which could provide individual Americans with diets that provide

specific health benefits, is a focus of the new USDA initiative *Agricultural Science Center of Excellence for Nutrition and Diet for Better Health* (ASCEND for Better Health). (NP 107, C3, PSB, Project No. 2032-51530-026-000D)

Publication: Larke, J.A., Bacalzo, N., Castillo, J.J., Couture, G., Chen, Y., Xue, Z., Alkan, Z., Kable, M.E., Lebrilla, C.B., Stephensen, C.B., Lemay, D.G. 2022. Dietary intake of monosaccharides from foods is associated with characteristics of the gut microbiota and gastrointestinal inflammation in healthy US adults. *Journal of Nutrition*. 153(1):106-119. <https://doi.org/10.1016/j.tjnut.2022.12.008>.

- **Genetic differences contribute to sex-dependent differences in blood lipids.** Some genetic differences known as single nucleotide polymorphisms (SNPs) in apolipoprotein (APO) genes are associated with unhealthy cholesterol levels and type 2 diabetes. However, more information is needed about how SNPs affect APOs, lipid markers, and lipid clearance in healthy U.S. adults after a high-lipid meal challenge. ARS scientists in Davis, California, studied subjects enrolled in a cross-sectional Nutritional Phenotyping Study and determined the association of five SNPs in APO genes with lipid markers. They found that in healthy subjects, the effect of SNPs on cholesterol metabolism is dependent on sex and body mass index. These findings support evidence indicating that adult blood cholesterol levels are dependent on genetics and gender, and that SNPs in APO genes have only limited effects on triglyceride metabolism. These results may have applications for designing precision nutrition applications to improve individual cholesterol levels. (NP 107, C3, PSB, Project No. 2032-51000-005-000D)

Publication: Wang, Y.E., Kirschke-Schneide, C.P., Woodhouse, L.R., Bonnel, E.L., Stephensen, C.B., Bennett, B.J., Newman, J.W., Keim, N.L., Huang, L. SNPs in apolipoproteins contribute to sex-dependent differences in blood lipids before and after a high-fat dietary challenge in healthy U.S. adults. *Biomed Central (BMC) Nutrition*. 8. Article 95, 2022.

## Component 4. Prevention of Obesity and Obesity-Related Diseases

The high prevalence of obesity in the American population has major economic, social, and public health consequences. Because obesity is an underlying contributor to many disorders, including cardiovascular disease, type 2 diabetes, nonalcoholic fatty liver disease, and several cancers, its increase fuels escalation of health care costs. Diabetes alone costs > \$170 billion dollars annually in the U.S. A prevalence of obesity above the national average is found in higher risk groups including African-Americans, Hispanic-Americans, and nightshift workers. Because reduction of excess body weight is difficult to achieve and even harder to sustain, experts are increasingly aware of the critical need for effective, proven methods for the primary prevention of weight gain, particularly in children.

### Problem Statement 4A: Understand the Causes and Effects of Obesity and Obesity-Related Disorders

The rise in obesity is the result of multiple factors, all with different degrees of impact. These factors include dietary, biological, behavioral, economic, and environmental. There is a need to further investigate the causal factors for obesity and sequelae such as heart disease and diabetes so that effective diet-, activity-, and science-based policy solutions to these problems may be developed.

#### *Accomplishments:*

- **A new way to reduce eating in the absence of hunger.** Hunger can drive humans and animals to eat, but in the absence of hunger, eating can also be triggered by the hedonic (pleasant sensations) value of foods. This "pleasure-driven" eating is a contributing factor to obesity. Researchers at the Children's Nutrition Research Center in Houston, Texas, discovered that a certain type of brain cells called 5-hydroxytryptamine (5-HT) neurons can suppress hedonic feeding. They found how

5-HT cells are regulated by nutrient intake and how these cells send signals to regulate feeding behaviors. These significant findings provide a framework to potentially target these specific cells for preventing and/or treating obesity. (NP 107, C4, PSA, Project No. 3092-51000-064-000D)

Publication: Cai, X., Liu, H., Feng, B., Yu, M., He, Y., Liu, H., Liang, C., Yang, Y., Tu, L., Zhang, N., Wang, L., Yin, N., Han, J., Yan, Z., Wang, C., Xu, P., Wu, Q., Tong, Q., He, Y., Xu, Y. 2022. A D2 to D1 shift in dopaminergic inputs to midbrain 5-HT neurons causes anorexia in mice. *Nature Neuroscience*. 25:646-658.

- **Obesity’s impact on childhood cognitive function.** ARS-funded researchers in Little Rock, Arkansas, designed studies to determine how body weight affects the academic success of overweight or obese children. They found that excess body weight affects a child’s ability to pay attention and perform tasks, such as simple math, that are important to succeed both in school and in the ‘real world.’ Differences were not always associated with the ability to complete a task, or to correctly solve problems; instead, the differences were observed in actual brain function. These findings are significant because the changes observed in the brain suggest these children are at risk for losing these abilities in adulthood or old age, particularly when significant environmental adversity is a factor. (NP 107, C4, PSA, C5, PSB, Project No. 6026-51000-012-000D)

Publication: Alatorre-Cruz, G.CI, Downs, H., Hagood, D., Sorensen, S.T., Williams, D.K., Larson-Prior, L.J. Effect of Obesity on Arithmetic Processing in Preteens With High and Low Math Skills: An Event-Related Potentials Study. *Front Hum Neurosci*, 10:16:780234, 2022.

**Infant temperament predicts adiposity development in the first year of life.** Recent estimates suggest that almost 23 percent of children between the age of 2 and 5 are overweight or obese, and that approximately 8 percent are overweight or obese before they are 2 years old. However, more information is needed about the factors correlated with weight status in infancy (0-12 months of age). Researchers at the Children's Nutrition Research Center in Houston, Texas, identified temperament characteristics in infants and assessed their body composition when they were 4 months old and again when they were 12 months old. They found that a positive affect at 4 months, such as how much a child smiles, laughs, and makes happy verbalizations predicted greater adiposity levels in a child at 12 months of age. This is the first study providing evidence that objective observations of infant temperament (i.e., observations by someone other than the child's primary caregiver) can predict adiposity later in a child’s life. These findings may help identify children at risk of developing excess adiposity in the first year of life and give researchers new factors to consider in predicting early-onset obesity. (NP 107, C4, PSA, Project No. 3092-51000-063-000D)

Publication: Wood AC, Momin SR, Senn MK, Bridgett DJ. Context Matters: Preliminary Evidence That the Association between Positive Affect and Adiposity in Infancy Varies in Social vs. Non-Social Situations, *Nutrients* 14(12):2391, 2022

- **Circulating microRNAs in young children differ with weight and insulin resistance.** ARS-funded researchers in Little Rock, Arkansas, obtained blood samples from children (5-9 years of age) to see if weight status and insulin resistance levels affect circulating blood levels of small molecules called microRNA (miRNA). The children were divided into groups with either normal weight (NW) or with overweight/obesity (OW/OB), and the latter group was further divided into an insulin-sensitive/metabolically healthy obese group and insulin-resistant/metabolically unhealthy obese group. All groups showed no differences in fasting blood glucose levels, but insulin concentrations were elevated in the OW/OB compared to the NW group. Eleven of the 188 measured miRNAs were differentially expressed between NW and OW/OB groups, and certain miRNAs were correlated with the degree of insulin resistance. These findings suggest that early childhood differences of circulating miRNA may help guide targeted prevention of obesity-related disturbances at an early stage. (NP 107, C4, PSA, Project No. 6026-51000-012-000D)



Publication: Santos, D., Porter-Gill, P., Goode, G., Delhey, L., Sørensen, A., Rose, S., Børsheim, E., Dalgaard, L.T., Carvalho, E. Circulating microRNA differ in the early stages of insulin resistance in prepubertal children with obesity. *Life Sciences*.  
<https://doi.org/10.1016/j.lfs.2022.121246>, 2023.

- **Maternal feeding, child eating, and weight.** It is clear that the way parents feed their children affects the child's long-term health, but more information is needed about how differences in child eating influence how parents feed their children. Children's Nutrition Research Center researchers in Houston, Texas, discovered that a child's motivation to eat and parental feeding styles played a role in his/her weight 3 years later. Multi-year data were collected from Hispanic Head Start mother/child groups, starting with children when they were 4-5 years old and then again when they were 7-9 years old. Unexpectedly, children of parents with authoritative feeding styles (described as balanced regarding parental control and autonomy support) were low on motivation to eat and had a higher risk for obesity. These findings contradict other studies indicating that balancing parental control and autonomy support (authoritative parenting style) is a more accurate indicator of better health outcomes in children. More research is needed to better understand feeding style approaches to feeding children and child outcomes, and characterizing differential parental feeding and child eating phenotypes may assist in tailoring childhood obesity prevention programs for target populations. (NP 107, C4, PSA, Project No. 3092-51000-063-000D).

Publication: Papaioannou, M.A., Power, T.G., O'Connor, T.M., Fisher, J.O., Micheli, N.E., Hughes, S.O. 2023. Child weight status: The role of feeding styles and highly motivated eating in children. *Children*. 10(3). Article 507, 2023

#### Problem Statement 4B: Develop and Evaluate Strategies to Prevent Obesity and Obesity-Related Diseases

Greater efforts must be made that address individual variation in maintaining a healthy weight, achieving a healthy body weight, and preventing the development of obesity and its related diseases. To date, most interventions have generally not been effective or sustainable at a group level. Researchers must develop a better understanding of the social, environmental, and cultural processes that guide individuals to adopt and sustain healthful food choices, eating behaviors, and physical activity patterns such as those recommended in the Dietary Guidelines for Americans.

##### *Accomplishment:*

- **A sugar-rich diet associated with lower decision-making performance and higher chronic stress.** The executive brain mediates and facilitates a set of cognitive functions, such as decision-making, planning, self- and emotional-regulation, and attention. The executive brain is particularly vulnerable to effects of psychological stress, and chronic stress, executive brain dysfunction, and related age-associated diseases such as Alzheimer's Disease are a rising public health concern. ARS researchers in Davis, California, compared how different dietary patterns affect executive brain function by using a cognitive test that specifically probes a person's ability to effectively weigh short-term reward with long-term consequences. A sugar-rich diet was associated with the lowest decision-making performance, higher self-reported psychological stress exposure, and activity changes in the autonomic nervous system. Diet patterns defined by more fruits, vegetables, or higher omega-3 fatty acids and seafood were associated with lower chronic stress exposure. These results provide new information that further supports the potential importance of whole diet patterns on preventing cognitive disease. (NP 107, C4, PSB, Project No. 2032-51530-025-000D)

Publication: Laugero KD, and Keim NL. A Diet Pattern Characterized by Sugar-Sweetened Beverages Is Associated with Lower Decision-Making Performance in the Iowa Gambling Task,

Elevated Stress Exposure, and Altered Autonomic Nervous System Reactivity in Men and Women. *Nutrients*, 2023; 15(18): 3930.

## Component 5: Life Stage Nutrition and Metabolism

Three of the six ARS Human Nutrition Research Centers have Congressionally-mandated missions to focus their work on specific portions of life, namely pregnant and lactating women, children, and the elderly. In addition to determining nutrient and physical activity requirements for these groups, enhanced understanding of metabolic processes in early and late life that differ from usually studied young adults is essential to develop more relevant recommendations, government policies and programs, and to contain health care costs. One aspect of this is the concept of “nutritional programming” that occurs during periods of development and can result in long term alterations of gene expression and future changes such as the slow loss of muscle mass among the elderly that leads to reduced calorie needs, frailty, and higher medical costs.

### Problem Statement 5A: Identify Dietary and Related Lifestyle Impacts for Healthy Development and Function from Conception to Old Age

Food and its components are essential to the fundamental processes of healthy development and aging. There are multiple gaps in our knowledge of those relationships in humans. These gaps limit the ability to make authoritative recommendations for nutrient requirements, dietary composition and patterns, and lifestyles that lead to health. With expansion of the aged population in the U.S., more people suffer from declines in vision, immune function, cognition, and musculoskeletal capability. Subsequently, there is greater demand for characterizing diet and lifestyle requirements that help maintain health and quality of life. Other data are essential to define the mechanisms by which foods and food components regulate metabolism, development, growth, and senescence. In many cases, identifying specific mechanisms requires use of animal and cell culture models and it is important that appropriate models are utilized.

#### *Accomplishments:*

**Developing optical skin measurements to assess infant dietary intake.** Developing evidence-based guidelines for infant nutrition requires an accurate understanding of the relationship between infant food intake and health, but infants cannot provide information about their diet. As an alternative, dietary biomarkers derived from measurements of a person’s body or specimens can provide information about infant dietary intake. Optical measurements of skin carotenoids, which are colorful compounds found in fruits and vegetables, are already used as biomarkers of childhood and adult fruit and vegetable intake. Researchers at the Children's Nutrition Research Center in Houston, Texas, found that optical skin carotenoid measurements can also be reliably conducted on infant fingers and the heels of their feet when they are 4, 6, and 8 months old. This measurement provides a new tool for researchers to continue studies on using biomarkers for measuring infant nutrition. (NP 107, C5, PSA, Project No. 3092-51000-061-000D)Publication: Moran, N. E., Cheng, J., Stroh, Rl, Zaidi, Yl, Hason, N., Musaad, S., and O’Connor, T. Noninvasive Reflection Spectroscopy Measurement of Skin Carotenoid Score in Infants Is Feasible and Reliable. *J. Nutr.* 152 (12):2966-2877, 2023.

- **Higher acculturation leads to worsening diet quality for most Hispanic Americans.** Adopting a Western diet can negatively affect the health of Hispanic immigrants, but it is unclear if different Hispanic American subpopulations have different relationships between acculturation and diet quality. ARS researchers in Stoneville, Mississippi, and University of Central Arkansas collaborators used data collected from a nationally representative sample of 2,924 Hispanic Americans to study diet quality differences in Mexican American groups and other Hispanic American groups. Their findings indicated that higher acculturation in all groups was associated with poorer scores for fruits, vegetables, protein foods, saturated fats, and sodium. They also



found that Mexican Americans groups had diets associated with poorer scores for added sugars and better scores for refined and whole grains, but other Hispanic American groups had poorer scores for dairy and fatty acids. These results suggest that collecting country of origin information may help researchers tailor nutrition interventions to address specific diet disparities within Hispanic American subpopulations. (NP 107, C5, PSA, Project No. 6001-51000-004-000D)

Publication: Thomson, J.L., Landry, A.S., Walls, T.I. Similarities and dissimilarities in diet quality differences by acculturation level between Mexican Americans and other Hispanic Americans: National Health and Nutrition Examination Survey 2015-2018. *Journal of Nutrition*. 153:2401-2412, 2023.

- **Cellular senescence may be associated with mobility problems in older adults.** Cellular senescence is a process related to the aging of many human cells and may be associated with the development of mobility disability. ARS-funded researchers in Boston, Massachusetts, collected blood samples from older women and men enrolled in the Lifestyle Interventions for Elders Study to obtain and measure circulating concentrations of proteins secreted by senescent cells. Then 1400 study participants were randomly assigned to either a structured physical activity or a healthy aging program. The researchers found associations between several senescence biomarkers and the onset of mobility disability and also found that study participants in the physical activity program had the same senescence biomarker levels as participants in the healthy aging program. These data suggest cellular senescence is a mediator of age-associated functional decline and indicates that physical activity can potentially attenuate this hallmark of aging. NP 107, C5, PSA, Project No. 8050-51000-104-000D)

Publication: Fielding, R.A., Atkinson, E.J., Aversa, Z., White, T.A., Heeren, A.A., Achenbach, S.J., Mielke, M.M., Cummings, S.R., Pahor, M., Leeuwenburgh, C., Lebrasseur, N.K. Associations between biomarkers of cellular senescence and physical function in humans: Observation from the lifestyle interventions for elders (life) study. *Geroscience* 44(6):2757-2770, 2022.

### Problem Statement 5B: Identify Determinants and Consequences of Nutritional Status, Diet and Body Composition on Metabolic Programming

Mammalian development proceeds via a specific series of irreversible steps from conception to adulthood that affects body structures, functions, and gene expression patterns. The irreversible nature of biological development involves diverse “critical windows,” developmental periods during which specific milestones must be achieved to lay the groundwork for subsequent steps. While it is clear that diet has a fundamental role in these developmental processes, there are relatively few data on the nutritional requirements and/or the mechanisms through which foods and food components function during these critical windows. Research on nutritional programming will lead to dietary recommendations during periods of development in order to optimize short- and long-term health.

#### *Accomplishments:*

- **Pregnant mother’s physical activity and newborn’s brain development.** ARS-funded researchers in Little Rock, Arkansas, studied how physical activity during pregnancy affects infant brain development. They tracked six interludes of physical activity by pregnant women and subsequently conducted MRIs on their infants’ brains 2 weeks after birth. Results showed significant relationships between physical activity during the first and second trimester and brain cortical development in newborns. The study also identified that higher physical activity levels were associated with greater brain cortical thickness, suggesting an indication of better cortical development. This study provides the first direct evidence that physical activity during uncomplicated pregnancy may be beneficial for the brain development of offspring. (NP 107, C5, PSB, Project No. 6026-51000-012-000D)

Publication: Na, X., Raja, R., Phelan, N.E., Tadros, M.R., Moore, A., Wu, Z., Wang, L., Li, G., Glasier, C.M., Ramakrishnaiah, R.R., Andres, A., Ou, X. 2022. Mother's physical activity during pregnancy and newborn's brain cortical development. *Frontiers in Human Neuroscience*. 10:943341.

- **Obesity's impact on childhood cognitive function.** ARS-funded researchers in Little Rock, Arkansas, designed studies to determine how body weight affects the academic success of overweight or obese children. They found that excess body weight affects a child's ability to pay attention and perform tasks, such as simple math, that are important to succeed both in school and in the 'real world.' Differences were not always associated with the ability to complete a task, or to correctly solve problems; instead, the differences were observed in actual brain function. These findings are significant because the changes observed in the brain suggest these children are at risk for losing these abilities in adulthood or old age, particularly when significant environmental adversity is a factor. (NP 107, C4, PSA, C5, PSB, Project No. 6026-51000-012-000D)

Publication: Alatorre-Cruz, G.CI, Downs, H., Hagood, D., Sorensen, S.T., Williams, D.K., Larson-Prior, L.J. Effect of Obesity on Arithmetic Processing in Preteens With High and Low Math Skills: An Event-Related Potentials Study. *Front Hum Neurosci*, 10:16:780234, 2022.