

FY 2015 Annual Report for National Program 107 Human Nutrition

The Human Nutrition National Program (NP 107) addresses high-priority problems of national importance as outlined in Strategic Goal 5 of the [ARS Strategic Plan for FY 2012-2017: Improve the Nation's nutrition and health](#). Specifically, this program contributes to Objective 1.1: Enable Americans to make health-promoting, science-based dietary choices. The mission of NP 107 is to define the role of food and its components in maintaining health throughout the life cycle. The vision of the program is that well-nourished Americans make health-promoting diet choices based on scientific evidence. To accomplish these goals, the Human Nutrition Program of ARS conducts basic and applied research resulting in discoveries at the molecular, cellular, individual, and population levels on nutrient requirements, metabolism, health, and food/nutrient intake of the U.S.

There are five research components in the [current Action Plan](#) for the program:

- 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

Selected accomplishments completed during fiscal year 2015 and expected to have high impact in the field are listed below. Links to publicly available documentation are provided after each result.

Chronic mental or emotional stress may predispose individuals to obesity. People experiencing elevated levels of chronic stress sometimes develop cravings for calorie-dense foods, in part because stress exposure could alter brain pathways in ways that lead to stronger reactions to highly rewarding (typically high-caloric) foods. ARS researchers in Davis, California, conducted a brain imaging study using functional magnetic resonance imaging to examine how brain activity is affected when women with self-reported elevated chronic stress levels view pictures of high-calorie foods. Viewing these pictures resulted in exaggerated activity in brain regions linked to reward and emotionally-based food intake, and reduced activity in regions that mediate self-control and decision making. Study participants also selected more high-fat/sweet foods from a voluntary snack food buffet. This neurophysiological and behavioral evidence supports a biological basis for poor food choice, dysfunctional eating habits, and obesity risk in persons experiencing chronic stress. These findings can encourage healthcare practitioners to incorporate stress-reduction techniques in the development of more effective weight-control strategies for people who experience elevated chronic stress levels.

Publication: Tryon MS, Carter CS, Decant R, Laugero KD. [Chronic stress exposure may affect the brain's response to high calorie food cues and predispose to obesogenic eating habits.](#) *Physiology & Behavior*. 2013; 120:233-242.

Postnatal nutrition and nerve development. Postnatal nutrition influences neurodevelopment, but it is not known if variations in early infant diet affect physiologic measures used to assess neurodevelopment. Vagal tone is strongly correlated with cognitive function, social behavior,

and emotional behavior of infants, children, and adults. ARS-funded researchers in Little Rock, Arkansas, assessed vagal tone stability in 2-year old children who as infants were either breast-fed (146 subjects), fed with milk formula (143 subjects), or fed with soy formula (137 subjects). Two-year olds who were breast-fed as infants had more stable vagal tone than 2-year olds who were formula-fed as infants, although gender affected this response in some groups. These results indicate that infant diet and gender are important modulators of early vagal tone development and may have an important influence on neurobehavioral and cognitive functioning. These findings will help healthcare practitioners guide new parents on improving infant nutrition for optimizing neurodevelopment.

Publication: Pivik RT, Andres A, Tennal KB, Gu Y, Cleves MA. [Infant diet, gender and the development of vagal tone stability during the first two years of life.](#) International Journal of Psychophysiology. 2015; 96:104–114.

Plant estrogens in infant soy formula do not affect reproductive organs at 5 years of age. Estrogens produced by the human endocrine system interact with male and female reproductive organs and stimulate much of sexual development. A long-term controversy exists about whether infant formula with soy protein, which contains very high levels of plant estrogens, could affect the development of reproductive organs in a similar manner. ARS-funded researchers in Little Rock, Arkansas, studied sexual development in three groups of 5-year old children who had been exclusively either breastfed, given cow's milk, or given soy formula for the first 4 to 6 months of life. Ultrasound was used to measure the volume of breast buds, uterus, ovary, prostate, and testes, which are all reproductive organs that develop during childhood. The reproductive organs of the three groups of children did not exhibit any differences in volume or structural characteristics. While continued follow-up through puberty is planned, these data provide initial evidence that soy formula has no measurable adverse effect on reproductive organs and can be safely consumed by infants who cannot tolerate cow's milk.

Publication: Andres A, Moore MB, Linam LE, Casey PH, Cleves MA, Badger TM. [Compared with feeding infants breast milk or cow-milk formula, soy formula feeding does not affect subsequent reproductive organ size at 5 years of age.](#) Journal of Nutrition. 2015; 145:871-875.

Lunches provided by schools are more nutritious than lunches brought from home. Claims have been made that “brown-bag” lunches children bring from home are more nutritious and cost less, and are, therefore, a better choice than meals provided in USDA-approved school lunch programs. ARS-funded researchers in Houston, Texas, studied the “brown-bag” lunches of about 350 elementary and intermediate school students. These meals contained higher levels of sodium and fewer fruits, vegetables, whole grains, and milk products than national school lunch program guidelines recommend. In addition, most of the lunches contained items that are not permitted in reimbursable school meals, such as desserts, snack chips, and sweetened beverages. These results highlight the need to educate parents about improving the nutritional quality of “brown-bag” lunches from home.

Publication: Caruso ML, Cullen KW. [Quality and cost of student lunches brought from home.](#) JAMA Pediatrics. 2015; 169:86-90.

Some children at increased risk of weight gain during the summer. An essential part of annual physical exams for children is a weight check, but annual visits do not help healthcare practitioners monitor seasonal fluctuations in weight. ARS-supported researchers in Houston, Texas, recently tracked weight changes in over 7,500 ethnically diverse children in elementary school. They found that Hispanic children and children who were overweight or obese gained more weight during the summer than during the school year. This pattern was not found in children of other ethnicities or children with healthy body weights. While the reasons for these seasonal fluctuations were not assessed, these findings indicate that strategies are needed outside of the school year to help children maintain healthy growth.

Publication: Moreno JP, Johnston CA, Chen TA, O'Connor TA, Hughes SO, Baranowski J, Woehler D, Baranowski T. [Seasonal variability in weight change during elementary school.](#) *Obesity*. 2015; 23:422-428.

Development and application of a new marker for vitamin B-12 status. Vitamin B12 deficiency is a serious problem in many areas of the world. Markers for vitamin status are important to accurately determine the presence and severity of deficiencies. However, traditional methods of assessing B12 status often inconsistently classify individuals or populations with vitamin B12 deficiencies. ARS researchers in Davis, California, in collaboration with researchers at Aarhus University in Denmark, have combined multiple traditional biomarkers to develop cB12, a new biomarker with improved capabilities for detecting metabolomic and neurological responses to vitamin B12 interventions. This new marker of vitamin B12 status is likely to be used widely in clinical practice, epidemiological investigations, and nutrition research to help identify and mitigate health issues associated with Vitamin B12 deficiencies.

Publication: Fedosov SN, Britio A, Miller JW, Green R, Allen LH. [Combined indicator of vitamin B12 status: modification for missing biomarkers and folate status, and recommendations for revised cut-points.](#) *Clinical Chemistry*. 2015; 53:1215-1225.

Characterization of specific phytochemicals in whole grain and their baked products. Epidemiological studies have shown that consumption of whole grains helps protect against chronic health conditions. ARS scientists in Beltsville, Maryland, investigated how baking affects differences in the levels of phytochemicals such as phenolic acids, carotenoids, and tocopherols, in whole and refined flours from two wheat varieties (Louise-soft white and Macon-hard white). The results showed that levels of phenolic acids, carotenoids, and tocopherols were significantly higher in all fractions made from whole wheat flour. Baking was observed to reduce the concentrations of carotenoids and tocopherols but did not significantly change the concentration of phenolic acids. These data give researchers a more comprehensive understanding of the components that play a role in potential health benefits of whole grain flour.

Publication: Lu Y, Luthria D, Fuerst EP, Kiszonas AM, Morris CF. [Effect of processing on phenolic acid composition of dough and bread fractions made from refined and whole-wheat flour of three wheat varieties.](#) *Journal of Agricultural and Food Chemistry*. 2014; 62:10431-10436.

Honey and high fructose corn syrup cause similar blood sugar responses. There are claims that the blood glucose response to the fructose in honey is different than the blood glucose response to sucrose or to high-fructose sugars in corn syrup and other sources. ARS-supported scientists in Grand Forks, North Dakota, conducted a human clinical trial and had participants consume 50 grams of either fructose, sucrose, or high-fructose syrup every day for 2 weeks. At the end of the 2 weeks, all participants had elevated serum triglyceride levels, indicating that the detrimental effects of elevated sugar consumption is not affected by the type of sugar consumed and that the chronic intake of honey, high fructose corn syrup, and sucrose in humans results in equivalent glycemic and insulin responses. These results add important knowledge regarding the sugar metabolism in glucose tolerant and glucose intolerant individuals which may impact dietary guidance regarding sugar intake and help diabetics manage their daily glucose metabolism more effectively.

Publication: Raatz SK, Johnson LK, Picklo MJ. [Consumption of honey, sucrose, and high-fructose corn syrup produces similar metabolic effects in glucose-tolerant and -intolerant individuals.](#) Journal of Nutrition. 2015; 145: 2265-2272.

Parenting practices identified to improve vegetable consumption by toddlers. Dietary habits are often established early in life. Since Americans of all ages eat less than half the recommended servings of vegetables, ARS-supported scientists in Houston, Texas, surveyed more than 300 mothers of pre-school children about their attitudes, habits, and emotions regarding children's nutritional needs and about actual vegetable consumption by their pre-school children. The researchers determined that half the variation in children's vegetable consumption could be explained by three factors, in decreasing order of importance: (1) actively involving the child in choosing vegetables in the store, (2) praising the child for eating vegetables, and (3) automatically including vegetables on the plate. This was the first study to test a behavioral model to predict effective parenting practices that increase vegetable consumption and should lead to designing successful interventions.

Publication: Diep CS, Beltran A, Chen TA, Thompson D, O'Connor T, Hughes S, Baranowski J, Baranowski T. [Predicting use of effective vegetable parenting practices with the Model of Goal Directed Behavior.](#) Public Health Nutrition. 2015; 18:1389-1396.

Exploiting normal biological pathways to prevent cataracts. The human eye lens requires soluble proteins to establish and maintain a clear lens, and cataracts develop as the eye lens loses its ability to eliminate insoluble proteins that develop from stresses and aging. ARS-funded researchers in Boston, Massachusetts, discovered pathways by which lens proteins are kept soluble and/or are recognized for degradation and elimination. The findings are essential for understanding how nutritional interventions into natural systems have the potential for helping preserve vision and diminishing the burden from cataract, which afflicts 17,000,000 people worldwide.

Publication: Liu K, Lyu L, Chin D, Gao J, Sun X, Shang F, Caceres A, Chang ML, Rowan S, Peng J, Mathias R, Kasahara H, Jiang S, Taylor A. [Altered ubiquitin causes perturbed calcium homeostasis, hyperactivation of calpain, dysregulated differentiation, and cataract.](#) Proceedings of the National Academy of Sciences USA. 2015; 112:1071-1076.

Rice consumption is associated with better adult nutrient intake and diet quality. Rice consumption has doubled in the United States over the last 20 years and enriched, fortified white rice makes up more than 70 percent of that increase. ARS-funded researchers in Houston, Texas, used data from the National Health and Nutrition Examination Survey (NHANES 2005-2010) to assess the association of adult rice intake with nutrient intake and diet quality. Rice consumption was associated with consistently better diet quality and nutrient intake, including better intakes of dietary fiber, folate, magnesium, iron and potassium, and greater consumption of fruit, dark green/orange vegetables, grains, meat/beans, and oils. These results show that including rice in the diet complements a pattern of healthy eating.

Publication: Nicklas TA, O'Neil CE, Fulgoni VL. [Rice consumption is associated with better nutrient intake and diet quality in adults: National Health and Nutrition Examination Survey \(NHANES\) 2005-2010.](#) Food and Nutrition Sciences 2014; 5:525-532.

Meal composition affects vitamin D absorption. An issue that complicates the process of correcting vitamin D deficiency is that individual responses to a given dose of the vitamin vary widely. ARS-funded researchers in Boston, Massachusetts, had previously found that supplemental vitamin D is absorbed more efficiently when the supplement is taken with a meal. They conducted a follow-up study of 50 healthy older adults to determine whether the presence of fat in the meal influenced vitamin D absorption. Their results indicate that absorption of vitamin D from a supplement was over 30 percent greater when the supplement was taken with a meal containing fat (in an amount commonly consumed) than with a fat-free meal. This research may lead to more effective strategies for older adults to achieve and maintain healthy vitamin D levels that protect bone and cognitive health. (NP 107, C3, PS3a, PM4.1.1, Project No. 8050-51000-092-00D)

Publication: Dawson-Hughes B, Harris SS, Lichtenstein AH, Dolnikowski G, Palermo NJ, Rasmussen H. [Dietary fat increases vitamin D-3 absorption.](#) Journal of the Academy of Nutrition and Dietetics. 2015; 115:225-230.

Nutritional trends in fast-food restaurant menu items. Excessive consumption of foods with higher levels of energy, sodium, saturated fat, and trans fat are associated with an increased risk of chronic disease. Trends in fast-food restaurant portion sizes may impact the consumption of these components. ARS-funded researchers in Boston, Massachusetts, examined the variability of portion sizes in popular food items in three U.S. fast-food restaurants over the past 18 years. Their study included tracking changes in portion size and the levels of energy, sodium, saturated fat, and trans fat in french fries, cheeseburgers, grilled chicken sandwiches, and regular cola. Overall, 56 percent of items decreased in energy content from 1996-2013, while energy content increased in 44 percent of the items. During the same time period, sodium levels in 18 percent of the items decreased significantly, while sodium levels in 33 percent of the items were higher, but the absolute differences were modest. In 2013, the energy content of a large-sized "meal" (cheeseburger, french fries, and regular cola) represented 65 to 80 percent of a 2,000-calorie-per-day diet, as well as a significant portion of recommended sodium intake. These findings suggest that efforts to promote reductions in energy, sodium, saturated fat, and trans fat intakes need to be shifted from emphasizing portion size to emphasizing additional factors such as total calories,

frequency of eating, number of items ordered, menu choices, and energy-containing beverages. (NP 107, C2, PS2a, PM4.1.1, Project No. 8050-51000-097-00D)

Publication: Urban LE, Roberts SB, Fierstein JL, Gary CE, Lichtenstein AH. [Temporal trends in fast-food restaurant energy, sodium, saturated fat, and trans fat content, United States, 1996–2013.](#) Preventing Chronic Disease. 2014; 11:140202