

## FY 2017 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 Area 1 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 and health, and intake of foods and nutrients in the U.S.

There are five research components in the [Human Nutrition Action Plan](#) for 2014-2019:

- 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 2017 and expected to have high impact in the field are listed below. Links to publicly available documentation are provided after each result.

Whole grain replacement of refined grains improves calorie balance. Dietary recommendations, including Dietary Guidelines for Americans, suggest replacing refined grains with whole grains, but the evidence for this is not consistent. ARS-supported scientists in Boston, Massachusetts, studied 81 older volunteers who were given meals for 6 weeks that were designed to maintain body weight containing either 0 or 7 ounces of whole grain foods daily. Whole grain intake led to a 92 calorie/day higher net energy loss compared with refined grain intake. There were modest beneficial changes in some of the large-intestinal bacteria and two types of immune cells in the bloodstream as a result of this diet. These data strengthen the recommendation from the Departments of Agriculture and Health and Human Services that at least half of a person's grain servings should come from whole grain foods.

Publication: Karl JP, Meydani M, Barnett JB, Vanegas SM, Goldin B, Kane A, Rasmussen H, Saltzman E, Vangay P, Knights D, Chen CO, Das SK, Jonnalagadda SS, Meydani SN, Roberts SB.

[Substituting whole grains for refined grains in a 6-wk randomized trial favorably affects energy-balance metrics in healthy men and postmenopausal women.](#) Am J Clin Nutr. 2017;105:589-599.

The glycemic index is highly variable and not a reliable dietary guide. The glycemic index (GI) was developed to identify how specific carbohydrate-rich foods influence blood sugar levels in the hours after consumption. Glycemic load (GL) incorporates both the GI and quantity of food to adjust for serving size. These measurements did not consider how blood sugar levels are affected when carbohydrate-containing foods are eaten in combination with other nutrients such as fat or protein. ARS-funded researchers in Boston, Massachusetts, found that adding protein to a person's diet resulted in a presumably healthier, significant decrease in measured GI and GL, whereas adding carbohydrate, fat, or fiber had little effect on these values. These data indicate significant variability in meal GI and GL determinations results from the consumption of different food combinations and caution against using these values for dietary guidance.

Publication: Meng H, Matthan NR, Ausman LM, Lichtenstein AH. [Effect of macronutrients and fiber on postprandial glycemic responses and meal glycemic index and glycemic load value determinations](#). Am J Clin Nutr. 2017;105:842-853.

Data briefs assess added sugars intake and changes in food intakes over time by Americans. Sugar has replaced fat in recent years as a focus of recommendations to restrict intake, despite relatively weak evidence for that. Essential data in this debate is knowing how much is being consumed. ARS scientists in Beltsville, Maryland, used What We Eat in America data from NHANES 2013-2014 that more than 40% of Americans meet the Dietary Guidelines for Americans by consuming no more than 10% of calories from added sugars, with a higher proportion of children not meeting that limit. In addition to age, ethnicity was a factor in sugar intake but household income was not. As a group, Americans reduced their sugar intake from 2003-2004 to 2013-2014 by three and a half teaspoons daily. This was accompanied by a reduction in solid fats and a very small but statistically significant increase of whole grains intake. All of these changes indicate improvements in dietary intake.

Data Briefs: [Added Sugars Intake of Americans](#), 2013-2014  
[Food Patterns Equivalents Intakes by Americans](#), 2003-2004 and 2011-2012

Beverage consumption among U.S. infants and toddlers. Limited data exist on beverage intake among U.S. children between birth and 24 months of age. Since the 2020 Dietary Guidelines for Americans will be expanded to include children under the age of 2 years, ARS-supported scientists in Houston, Texas, in collaboration with colleagues from Deakin University in Australia used NHANES data from over 2700 children. In infants under 1 year of age, infant formulas were the most commonly consumed beverage with three of four children given them. Far fewer infants consumed breast milk (42% before 6 months and 24% from 6-12 months). In toddlers, 12-24 months old, the most common beverages were plain milk (84%), water (69%), 100% fruit juice (52%), and sweetened beverages (31%). Children from lower income households and certain ethnic minorities were more likely to consume sweetened beverages and fruit juice and less likely to consume breast milk. Disparities in beverage consumption are apparent early in life.

Publication: Grimes CA, Szymlek-Gay EA, Nicklas TA. [Beverage Consumption among U.S. Children Aged 0-24 Months: National Health and Nutrition Examination Survey \(NHANES\)](#). Nutrients. 2017;9: E264.

High folate intake is linked with nerve damage risk in older adults with a common gene variant. One in six Americans carries two copies of a genetic variant in the gene for a vitamin B12 transport protein. In a study of more than 170 older adults, ARS-supported scientists in Boston, Massachusetts, collaborated with colleagues from Boston University and Pfizer, Inc., and found that individuals with the gene variant were three times more likely to have a type of nerve damage called peripheral neuropathy. Subjects with the variant who consumed more than twice the recommended amount of folate were seven times more likely to develop peripheral neuropathy. These results strongly suggest that older people should exercise caution in taking folic acid supplements and limit their folate intake to no more than the recommended amount. Publication: Sawaengsri H, Bergethon PR, Qiu WQ, Scott TM, Jacques PF, Selhub J, Paul L. [Transcobalamin 776C→G polymorphism is associated with peripheral neuropathy in elderly individuals with high folate intake](#). Am J Clin Nutr. 2016;104:1665-1670.

Dietary fiber, intestinal bacteria, and stool habits in children. In a series of studies, ARS-supported scientists in Houston, Texas, for the first time characterized the pattern of bathroom habits in healthy children. This is important given the large variation of this in adults and that altered stool habits are related to the development of long-term belly pain in about 20% of school-aged children. Bacteria in the

intestine influence the stool pattern through production of methane gas, which reflects fermentation of food by bacteria and how fast food moves along the intestinal tract. Finally, it was shown that added fiber to the diet of children 7-18 years of age with frequent belly pain led to significant reduction of symptoms. Dietary fiber is one of the shortfall nutrients in the U.S. and has the potential to improve gastrointestinal health in children and adults.

Publications: Chumpitazi BP, Weidler EM, Shulman RJ. [Lactulose Breath Test Gas Production in Childhood IBS Is Associated With Intestinal Transit and Bowel Movement Frequency.](#) J Pediatr Gastroenterol Nutr. 2017;64:541–545.

Shulman RJ, Hollister EB, Cain K, Czyzewski DI, Self MM, Weidler EM, Devaraj S, Luna RA, Versalovic J, Heitkemper M. [Psyllium Fiber Reduces Abdominal Pain in Children With Irritable Bowel Syndrome in a Randomized, Double-Blind Trial.](#) Clin Gastroenterol Hepatol. 2017;15:712-719.

Education is insufficient to promote consumption of fruits and vegetables. Almost all dietary recommendations worldwide, including the Dietary Guidelines for Americans, emphasize increased fruit and vegetable intake but few populations achieve the recommended intake levels. A group of 740 participants in the Farmers' Market Nutrition Program in urban New Jersey received a single web-based lesson to promote fruit/vegetable consumption and cash value vouchers. Although knowledge of the items available at markets increased and modest gains occurred in redemption of vouchers, fruit/vegetable intake did not improve over time. The results suggest limited education is insufficient to increase healthier choices and it remains to be established how to improve diets of Americans.

Publication: Di Noia J, Monica D, Sikorskii A, Cullen KW. [Outcomes of a randomized controlled trial of nutrition education to promote farmers' market fruit and vegetable purchases and consumption among women enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children \(WIC\).](#) BMC Nutrition. 2017;3:48.

Colon inflammation accompanies an increase of unhealthy gut bacteria. Consumption of a diet that induces obesity in laboratory animals also increases development of colon cancer but the mechanism is not established. ARS researchers in Grand Forks, North Dakota, along with collaborators from the University of Massachusetts, found that consumption of a diet that induces obesity increases inflammatory status and disease-causing bacteria in the colon of mice. The latter finding resulted from reduced antimicrobial peptides released from the specialized cells lining the colon. The importance of the microbiota was seen in these results, driving intestinal inflammation that increases the risk of colon cancer. A second study with colleagues from the University of Vermont, found that increased cell growth and expression of a gene commonly altered in colon cancer resulted from feeding a high-fat diet to induce obesity, as well as modifying families of bacteria in the colon. The metabolism of colon bacteria and their contribution to host health are being increasingly recognized as major factors responsive to changes in diet.

Publications: Guo X, Li J, Tang R, Zhang G, Zeng H, Wood RJ, Liu Z. [High Fat Diet Alters Gut Microbiota and the Expression of Paneth Cell-Antimicrobial Peptides Preceding Changes of Circulating Inflammatory Cytokines.](#) Mediators Inflamm. 2017;2017:9474896.

Zeng H, Ishaq SL, Zhao FQ, Wright AD. [Colonic inflammation accompanies an increase of  \$\beta\$ -catenin signaling and Lachnospiraceae/Streptococcaceae bacteria in the hind gut of high-fat diet-fed mice.](#) J Nutr Biochem. 2016;35:30-36.