



The Pennington Biomedical Research Center (PBRC) has gained national prominence in nutrition research since its origin in the early 1980s when a mutually beneficial research cooperation was established with a new Army biomedical nutrition research initiative. Research conducted by PBRC in collaboration with the U.S. Army Research Institute of Environmental Medicine (USARIEM) has led to new DoD nutrition guidelines and policies such as nutritional requirements in adverse operational environments, caloric and macronutrient standards for field rations, use of performance-enhancing ration supplements, permissible duration for feeding operational rations, appropriate levels of Basic Daily Food Allowance for specialized units, and nutritional requirements of military women.

Background

A series of specially funded cooperative agreements between PBRC and the U.S. Army Research and Material Command (USAMRMC) has provided high-quality analytical laboratory, nutrition database, and metabolic unit support for DoD nutrition-related research programs. The program currently supports the RDT&E-funded Military Nutrition research programs at the U.S. Army Soldier Systems Center (Natick) and USARIEM laboratories, as well as the Ration Sustainment Testing program. PBRC personnel frequently travel to DoD field studies to collect samples, returning to PBRC for laboratory analyses. Additionally, PBRC conducts research that complements and extends USARIEM's intramural program in areas of nutritional neuroscience, stress, physical, and mental performance, immune function, and garrison feeding. The PBRC program is periodically peer-reviewed by an external panel from the Committee on Military Nutrition Research (CMNR), Institute of Medicine (1988, 1990, 1996). This effort has led to significant improvements of operational rations, better understanding of energy and nutritional requirements for combat, and modifications in garrison feeding.

Recent Goals and Accomplishments

Stable Isotope Laboratory

Heavy atoms (non radioactive) are used as tracers to measure energy expenditure and changes in body water in free-ranging soldiers, marines, and sailors during field training in extreme climates. The lab showed that soldiers at work expend 4,000 kcal, even though their energy intakes are typically 75 percent or less of this requirement. In more extreme specialized training, the lab documented that energy expenditures may be as high as 8,000 kcal/24 hrs. in men and 4,800 kcal/24 hrs in women. Measurements of energy expenditure in studies in Alaska confirmed that the Military RDA for energy was adequate under these cold weather conditions. A field study in a desert environment showed that consumption of a carbohydrate supplemental drink significantly increased energy intake and reduced an energy imbalance.

Rangers were shown to expend more energy in hot, humid field environments than their assumed energy requirements. The lab also participated in studies on the limits of human endurance, including Norwegian Ranger studies, the Trans-Greenland Expedition, and Marine field exercises. Measurements of water intake using deuterium labeled water demonstrated that hydration was adequate in airmen consuming a new survival ration during a five-day survival exercise. Body water changes were also measured in several high altitude studies in relation to acute mountain sickness, with one study showing that hydration status decreased within one day at altitude, and that the effect was retained for at least six days after return to sea level.

Clinical Chemistry Laboratory for Human and Food Samples

This lab supports USARIEM and PBRC research projects with testing, field data collection, and methods development. For military studies, the lab developed a nutritional assessment panel which includes metabolic markers, vitamin E, vitamin A, vitamin C, enzymatic markers of B vitamins, folate, vitamin B12, prealbumin, retinol binding proteins, and other markers. The lab has adapted



PBRC and USARIEM collaborative research has led to significant DoD nutrition guidelines and policies

methods for automation for salivary, urine, and plasma caffeine, salivary melatonin, glycerol, free fatty acids, lactate, ammonia, selenium, bromide, amino acids, retinol binding protein, fecal polyethylene glycol, urinary PABA and PAH, glutathione peroxidase, and countless immuno assays. A rapid, accurate, and easily automated method for analysis of vitamin C in blood, pharmaceuticals, and food was developed and patented. A method for the analysis of nitrogen, calcium, magnesium, phosphorus, sodium, and potassium in food, feces, and urine by chemiluminescence and inductively coupled plasma emission spectrometry was developed. Another original method was an ELISA method for measuring genotypes of fatty acid binding protein.

Stress, Nutrition, and Mental Performance

A multidisciplinary team is working to identify nutritional interventions for stress-induced behavior. The lab uses sleep deprivation and restraint models to identify the basic mechanisms that mediate stress-induced decrements in behavior. The lab discovered that ApoE is a factor that determines stress-responsiveness in mice: ApoE repairs neuronal damage. This information could be



PBRC laboratory research identifies nutritional interventions to sustain health and performance in operational environments

used to identify people with special susceptibilities to the negative aspects of stress. The lab is searching for additional markers of stress responsiveness. It is also developing an animal model that mimics human trials of exhaustive physical exercise to determine the optimal timing and composition of glucose and fat supplements to improve physical and cognitive performance.

Nutrition, Stress and Work Performance

A study using Special Operations Forces conducted at the PBRC demonstrated that chronic energy restriction in active young men and women decreases physical performance levels. A current study is evaluating creatine monohydrate supplementation to improve swimming power. The lab also developed new methodologies, including a skill-oriented task to assess anaerobic power and reaction time and a process to isolate myosin heavy chain protein from human skeletal muscle and to measure its synthesis rate in living subjects.

Nutrient Database Integration Laboratory

This lab analyzes food intake for military nutrition studies such as: Savannah Ranger Study, El Paso Sergeants Major Academy Study, Special Forces Creatine Study, Fort Lewis Ranger Study, and a Marine field study of T-rations. PBRC programmers are streamlining the delivery of dietary intake information by setting up a custom-designed MiDAS System for USARIEM.

Enhancing Military Diets

In consultation with the Armed Forces Recipe Services and Armed Forces Food Policy Council, PBRC devises strategies for improved garrison intake using behavior modification techniques. A survey of 2,000 military members from nine bases and representing all services determined current eating trends. This project produced over 60 modified recipes developed to meet Army needs and are now included in the master recipe file. These recipes serve 100 and provide lower fat and sodium intake, incorporate ethnic preferences, accommodate vegetarian diets, and expand breakfast choices. The PBRC designed and implemented a model health promotion program for military service personnel and their families at Fort Polk. Nutritional assessments were conducted on 200 military wives to establish routine eating, activity, and other behavioral patterns. Cardiovascular risk assessments of 125 military families were also performed. Based on this information, a program for family health promotion, including prudent eating, exercise, stress and smoking reduction was developed and implemented on about 70 military families. And, a manual providing instructions for developing similar programs was produced.

Stress, Nutrition, and Immune Function Laboratory

This lab evaluates stress-induced immune modulation in animals and humans. A rodent sleep deprivation model for stress-induced changes in immune function was developed. Using this model, the impact of dietary fat acids on immune responses and stress-induced immune function was assessed. The lab demonstrated that animals deprived of sleep and fed a high-fat diet suffer from impaired immune function, while animals deprived of sleep but fed a low-fat diet have normal immune function. This can be further explored through clinical investigations.

Metabolic Unit Project

Studies through this project, in collaboration with NASA, included demonstrating the benefits of testosterone and alendronate to prevent the loss of bone and muscle mass caused by a novel model of weightlessness. A trial conducted in the Center's sleep lab provided conclusive evidence of the relative benefits for alertness and performance of caffeine, tyrosine, phentermine and amphetamine during sleep deprivation. Additionally, the study documented the negative effects on recovery sleep produced by amphetamine. These findings benefit policy development for sustained operations for warfighters.

*For more information on research projects and updates at the
Pennington Biomedical Research Center
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