Nutrition and metabolism during prolonged Earth orbit

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There are many physiological adaptations that occur during exposure to microgravity and these have major nutritional considerations (1). Nutrition research has been conducted in U.S. long duration space flight programs including Skylab, Shuttle/Mir and International Space Station. Nutritional perturbations include psychological/behavior and performance especially the sleep and circadian rhythm disturbances, fluids and electrolytes related to cardiovascular and renal functions, musculoskeletal changes including changes in body composition and bone and muscle functions, neurosensory adaptations includes taste and odor sensitivities, and hematological changes related to blood volume and red blood cells.

Psychological health is provoked by stress, lack of sleep, and hunger. Fluid shifts include reduction of plasma volume and extracellular fluids which reduces the blood volume that in term affects the cardiovascular system. The lack of gravity reduces muscle volume and bone mass. This is exacerbated by loss of appetite, reduced energy consumption, and consequently reduced protein synthesis. Total energy requirements during space flight are similar to the crew members total energy requirement on Earth. Bone changes include reduction of bone formation and increased bone resorption as measured by bone metabolism markers. Countermeasures research on the bone and muscle losses include dietary calcium, sodium, potassium, Vitamin D, and Vitamin K along with exercise protocols. Although antidotal, altered taste and odor sensitive have not been documented during space flight, but may explain some of the loss of appetite. Research is continuing to provide high quality food without the availability of frozen or refrigerated foods. The types of foods most successful have been theromostabilized food products. Hematological changes include the decrease in red blood cell synthesis due to decreased erythropoietin synthesis. There is an increased iron storage as ferritin and potentially a decrease in iron gastrointestinal absorption. The interactions of the increased tissue iron levels and radiation are topics for research.

The human body makes major physiological and psychological adjustments to microgravity and exposure to radiation, as well as the stress of living and working in very confined space. The astronauts make these adjustments to have a productive stay in space. Nutrition research emphasizes the mitigation strategies to maximize the astronauts' productivity.

1. Lane HW, Schoeller DA (ed). Nutrition in Spacefight and Weightlessness Models. CRC Press, Baton Raton, Florida, 2000.