Appetite and Food Intake during 11 days of Mild Hypobaric Hypoxia

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Introduction

Reduced food consumption and loss of body mass and muscle mass have been observed during spaceflight. Hypoxic conditions that astronauts may encounter on exploration missions may further implicate satiety signals and dietary intake. Appetite, food intake, and satiety hormones were investigated under the conditions of mild hypoxia and high energy output during simulated extravehicular activity (EVA) to determine the adequacy of a mission relevant space food system to support energy balance and body composition.

Methods

Foods realistic to early Artemis missions was packed by meal for each subject for the 11-day test based on estimated energy requirements (EER) and estimated EVA caloric requirements. No hot water or food warmer was provided and only room temperature water was available to rehydrate food and beverages in-mission, mimicking plans for early Artemis missions. Measures included food records (pre-mission, in-mission); fasted body weight (pre-mission, in-mission); Dual-energy X-ray absorptiometry (DXA) (pre-mission, post-mission); subjective ratings and feedback of food acceptability, mealtime and meal preparation sufficiency, appetite, and nausea (in-mission); and circulating ghrelin and leptin concentration in fasted blood samples (pre-mission, in-mission: pre-post EVA).

Results All subjects consumed fewer calories in-mission than predicted. On average, subjects consumed 341 calories less on EVA days compared to non-EVA days in-mission (p=0.0511). The total weight loss estimate from daily weight measurements (-1.1 kg, p=0.0028) is consistent with underconsumption and supported by DXA measurements (-1.3 kg total body mass, p=0.0123 and -1.6 kg fat mass, p=0.0016). In general, most foods that were consumed were given acceptable scores, but subject comments indicated that the most acceptable foods were those not intended to be heated. Comments also indicated that subjects found their favorite foods early in the mission and avoided the foods that they did not like throughout the mission. Habitability scores indicated that overall aspects of the food system were considered borderline or unacceptable over the length of this mission. Foods that caused gas were avoided pre-EVA to prevent discomfort during pressure changes. Average fruit and vegetable intake decreased during the mission, dropping from 4.8 servings/d pre-mission to 3.4 servings/d on non-EVA days in-mission (p=0.0872) and 2.3 servings on EVA days (p=0.0020). Fasting ghrelin concentrations tended to be lower pre-EVA and on non-EVA days when exposed to mild hypoxia compared to normoxic conditions pre-mission and post-EVA (p=0.0136). Fasting levels of leptin did not change.

Discussion

Food intake was reduced in-mission, resulting in a caloric deficit and weight loss for most subjects. Crew food and appetite ratings and comments indicated this was due to a combination of food choices, lack of preference, lack of preparation capability, lack of time for meal preparation, consumption, and cleanup, and physiological challenges with the changing pressure. The regulation of appetite stimulating hormone ghrelin, but not the appetite suppressor leptin, appeared to be sensitive to hypoxic conditions.

Conclusions

Food preparation capabilities and time for meals are important for promoting adequate food intake. Reduced appetite and food intake during missions may further be aggravated under hypoxic conditions through the suppression of ghrelin. Lack of time for meals on EVA days, and avoidance of potential gas-causing foods (e.g., health promoting fruits and vegetables) prior to EVAs, demonstrate the importance of scheduling ample recovery time between EVA days.