National Aeronautics and Space Administration

Assessment of Nutritional Intake During Space Flight and Space Flight Analogs

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Objective & Purpose

- Discuss physiological systems affected by microgravity
- Report dietary intake data from multiple space programs
- Present implications for those on Earth

Adaptation to Weightlessness

Psychological, behavioral, and performance issues

Sleep and circadian rhythm disturbances

Fluid shifts, hematological changes

Muscle loss

Neurosensory adaptations

Taste and odor sensitivity

Cardiovascular adaptations

Gastrointestinal alterations

Bone loss

Environmental issues

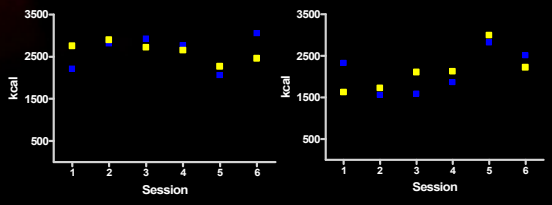
Methods of Data Collection

- Weighed Diet Records
- Diet Diaries
- Food Frequency Questionnaires

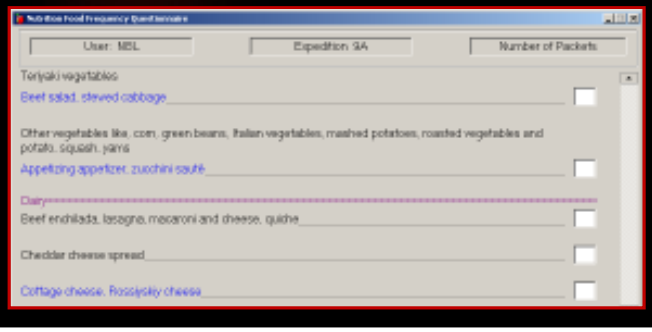
Weighed Diet Records

Flight Food Frequency Questionnaire

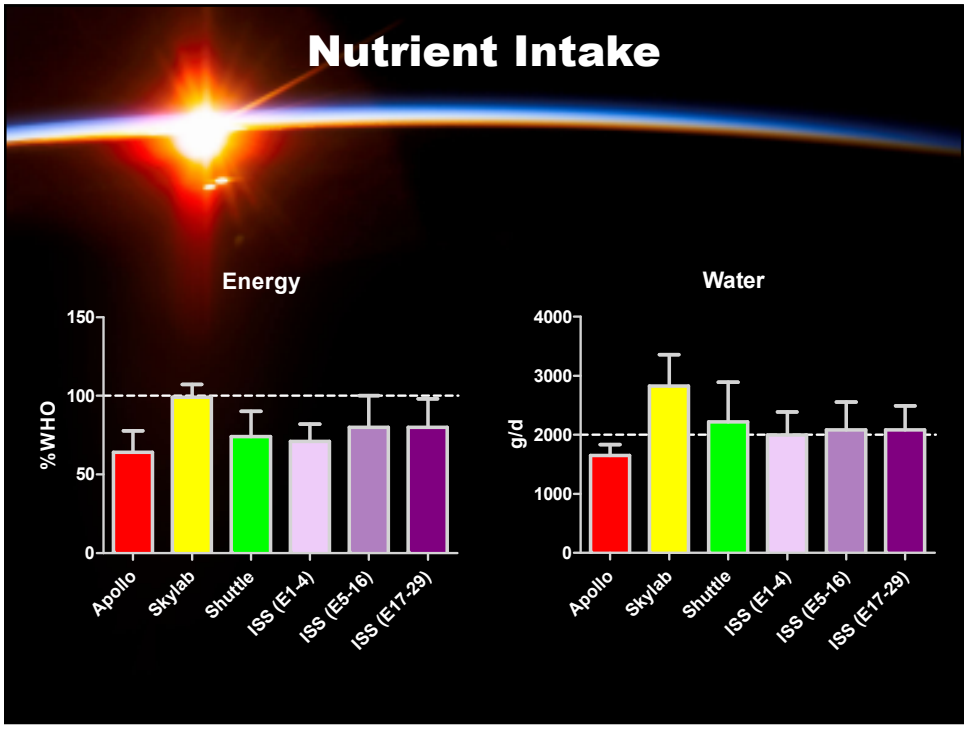
Diet barcoded log vs FFQ

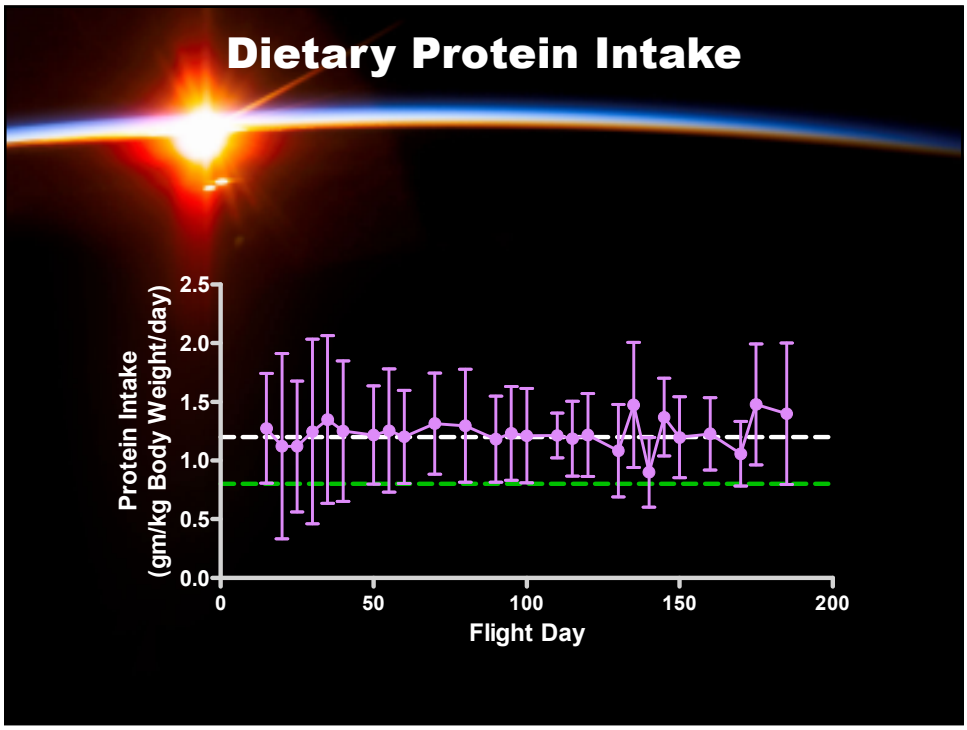


Barcode
FFQ

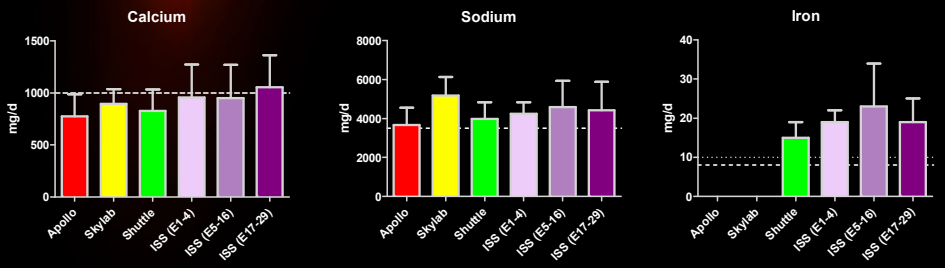


J Nutr. 131: 2053-2061, 2001


Nutrient Intake
Energy
% WHO
150
100
50
0
Apollo
Skylab
Shuttle
ISS (E1-4)
ISS (E5-16)
ISS (E17-29)
Water
g/d
4000
3000
2000
1000
0
Apollo
Skylab
Shuttle
ISS (E1-4)
ISS (E5-16)
ISS (E17-29)


Dietary Protein Intake
Protein Intake
(gm/kg Body Weight/day)
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
Flight Day

Nutrient Intake



Vitamin D

- Vitamin D status after early long-duration space flight
- Early issues of concern:
  - Content and stability in food
  - Daily dose
  - Vitamin D metabolism in flight

	Vit D (IU)
Flight Requirement (per day)	800
Menu	172 ± 44
Salmon	396
Tuna	152
Breakfast Drink	116
Tuna Noodle Casserole	96
Cornflakes	88
Tuna Salad Spread	84
Bran Chex	68
Scrambled Eggs	64
Bread Pudding	56
Granola w/Raisins	44
Tapioca Pudding	44
Teriyaki Beef	36
Pork Chops	32
Vegetable Quiche	28
Potato Soup	28

Ground Analogs for Space Flight

Experimental Research: Pro K

- Prescribe 4-d controlled diets twice before and 4 times during flight
  - High Apro/K: 1.0-1.3 g/mEq
  - Low Apro/K: 0.3-0.6 g/mEq

L-180	L-45	FD15	FD30	FD60	FD120	FD180
4-d High APro:K	4-d Low APro:K	4-d Low APro:K	*4-d Monitored Diet*	4-d Low APro:K	4-d High APro:K	4-d High APro:K

- Blood and urine samples were collected at the end of each session

Net Acid Excretion: Estimated from Diet

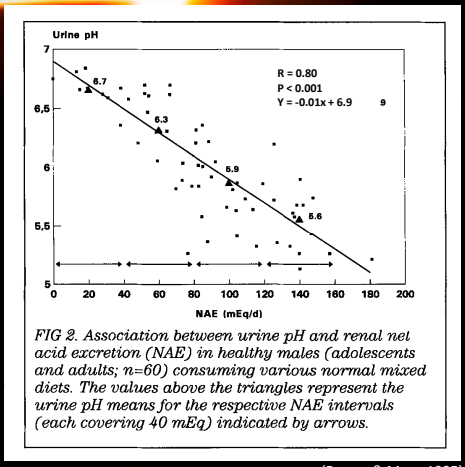
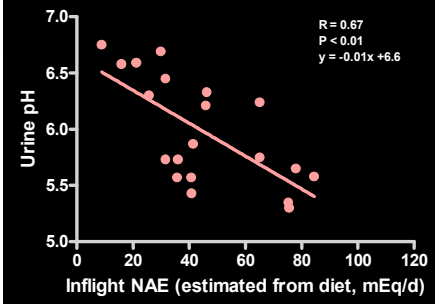


FIG 2. Association between urine pH and renal net acid excretion (NAE) in healthy males (adolescents and adults; n=60) consuming various normal mixed diets. The values above the triangles represent the urine pH means for the respective NAE intervals (each covering 40 mEq) indicated by arrows.

(Remer & Manz 1995)



NAE= (S + P + Cl + OA) – (Na + K + Ca + Mg)

Nutrients of Concern

Insufficient	Excess
• Calories	• Iron
• Fluid	• Sodium
• Vitamin D	? Animal Protein

Microgravity as a Model to Study Nutrition Issues on Earth

- Body composition changes in aging
- Bone demineralization/osteoporosis
- Role of diet in preventing muscle loss
- Connection of energy needed for specific work tasks to determining energy requirements in paraplegia and quadriplegia
- Regenerative food systems for expanding world nutritional needs
- DRI contribution