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
- Neurosensory adaptations
  - Taste and odor sensitivity
  - Cardiovascular adaptations
- Sleep and circadian rhythm disturbances
- Gastrointestinal alterations
- Fluid shifts, hematological changes
- Bone loss
- Muscle 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

**Nutrient Intake**

- **Energy**
- **Water**

**Dietary Protein Intake**
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

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Flight Requirement (per day)</th>
<th>Menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin D (IU)</td>
<td>800</td>
<td>172 ± 44</td>
</tr>
<tr>
<td>Salmon</td>
<td>396</td>
<td></td>
</tr>
<tr>
<td>Tuna</td>
<td>152</td>
<td></td>
</tr>
<tr>
<td>Breakfast Drink</td>
<td>116</td>
<td></td>
</tr>
<tr>
<td>Tuna Noodle Casserole</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>Cornflakes</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Tuna Salad Spread</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Bran Chex</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Scrambled Eggs</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Bread Pudding</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Granola w/Raisins</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Tapioca Pudding</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Teriyaki Beef</td>
<td>36</td>
<td></td>
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<tr>
<td>Pork Chops</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Vegetable Quiche</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Potato Soup</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>
Ground Analogs for Space Flight

• 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

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

Experimental Research: Pro K

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• Blood and urine samples were collected at the end of each session
Net Acid Excretion: Estimated from Diet

\[ \text{NAE} = (S + P + Cl + OA) - (Na + K + Ca + Mg) \]

Nutrients of Concern

**Insufficient**
- Calories
- Fluid
- Vitamin D

**Excess**
- Iron
- Sodium
- Animal Protein

*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.*

(Remers & Mantz 1995)
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