Human Adaptation to Space: Space Physiology and Countermeasures

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Astronauts experience a spectrum of adaptations in flight and postflight. These adaptations include:

- Balance disorders
- Cardiovascular deconditioning
- Decreased immune function
- Muscle atrophy
- Bone loss

Other areas affected by spaceflight include:

- Neurovestibular
- Cardiovascular
  - Bone
  - Muscle
- Immunology
- Nutrition
- Behavior
Space Adaptation Syndrome (SAS)

- approximately 70% of all astronauts traveling into space experience SAS symptoms, which range from nausea and light headedness to vomiting. The exact cause of SAS is unknown, but it is believed that it is caused by conflicting sensory inputs from the vestibular organ (inner ear) and the eyes. SAS symptoms normally last only for a day or two and can be treated by medication.
Space Adaptation Syndrome (SAS)

- Space Motion Sickness (SMS)
- Headache
- Back Pain
- Insomnia
- Nasal Congestion
- Constipation
- Nosebleed
- Urinary Retention
- Urinary Incontinence
Transitioning Data/Technology/Solutions to Operations

Research → Operational
ISS Expeditions 1-16

- 20 Astronauts on ISS
  - 17 males
  - 3 females
- Average age 47.2 years young
- Average length of mission 174.2 days
  - Longest mission 215 days
  - Shortest mission 133 days
**Countermeasure**

- an action, process, device, or system that can prevent, or mitigate (negate or offset) the effects of threats to a human; a threat is a potential or actual adverse event that may be malicious or incidental, and that can compromise the health and/or performance of an individual and the integrity of mission
This integrated system supports crew capability for normal and contingency ops. There is limited redundancy and crossover between the elements of the CMS system.
Exercise Device Availability

ISS Exercise Hardware Availability Timeline

- CEVIS Assembly
  - restricted to arm ergometry
  - failing control panel
  - CCC Installed
  - DC power converter failure
  - failed control panel; CCC installed

- I-RED Assembly
  - SchRED replaces I-RED
  - Incorrect thimble on new cord
  - 7th fwd stbd roller deteriorated

- TVIS Assembly
  - Correct thimble on new cord
  - 7th fwd stbd roller deteriorated

Timeline:
- EXP1: 10/00
- EXP2: 03/01
- EXP3: 08/01
- EXP4: 12/01
- EXP5: 06/02
- EXP6: 11/02
- EXP7: 04/03
- EXP8: 10/03
- EXP9: 10/04
- EXP10: 04/05
- EXP11: 09/05
- EXP12: 03/06
- EXP13: 09/06
- EXP14: 04/07
- EXP15: 10/07
Biomedical Data

Data Collected via Medical Requirements
Assessments of:
- Bone
- Aerobic Fitness
- Functional Fitness
Decreased Bone Mineral Density

BMD % Change from Preflight Expeditions 1-16 (n=20)
Decreased Bone Mineral Density

Pre and Post Bone Mineral Density - II
Expeditions 1-16 (n=20)

Pre and Post Bone Mineral Density - I
Expeditions 1-16 (n=20)
Bone Mineral Density Recovery

Pelvis
Loss_0 = 7.7%  
Recovery Half-life = 97 d

Femoral Neck
Loss_0 = 6.8%  
Recovery Half-life = 211 d

Trochanter
Loss_0 = 7.8%  
Recovery Half-life = 255 d
Estimated In-flight and Post-flight Aerobic Capacity

Percent Change in Estimated VO2 Index from Pre-Flight Expeditions 1-16 (n=20)
Recovery of Functional Fitness

Postflight Functional Fitness Expeditions 1-16 (n=20)
Biomedical Results of ISS Expeditions 1-16

Summary Slide

Purpose: Highlight the biomedical data captured during International Space Station expeditions 1 - 16 via the medical requirements testing

Content: Graphic assessments of physiological and performance. The physiological parameters assessed include skeletal and cardiovascular. Performance parameters assessed include aerobic capacity, strength, flexibility, and endurance measurements.