Human Adaptation to Space: Space Physiology and Countermeasures

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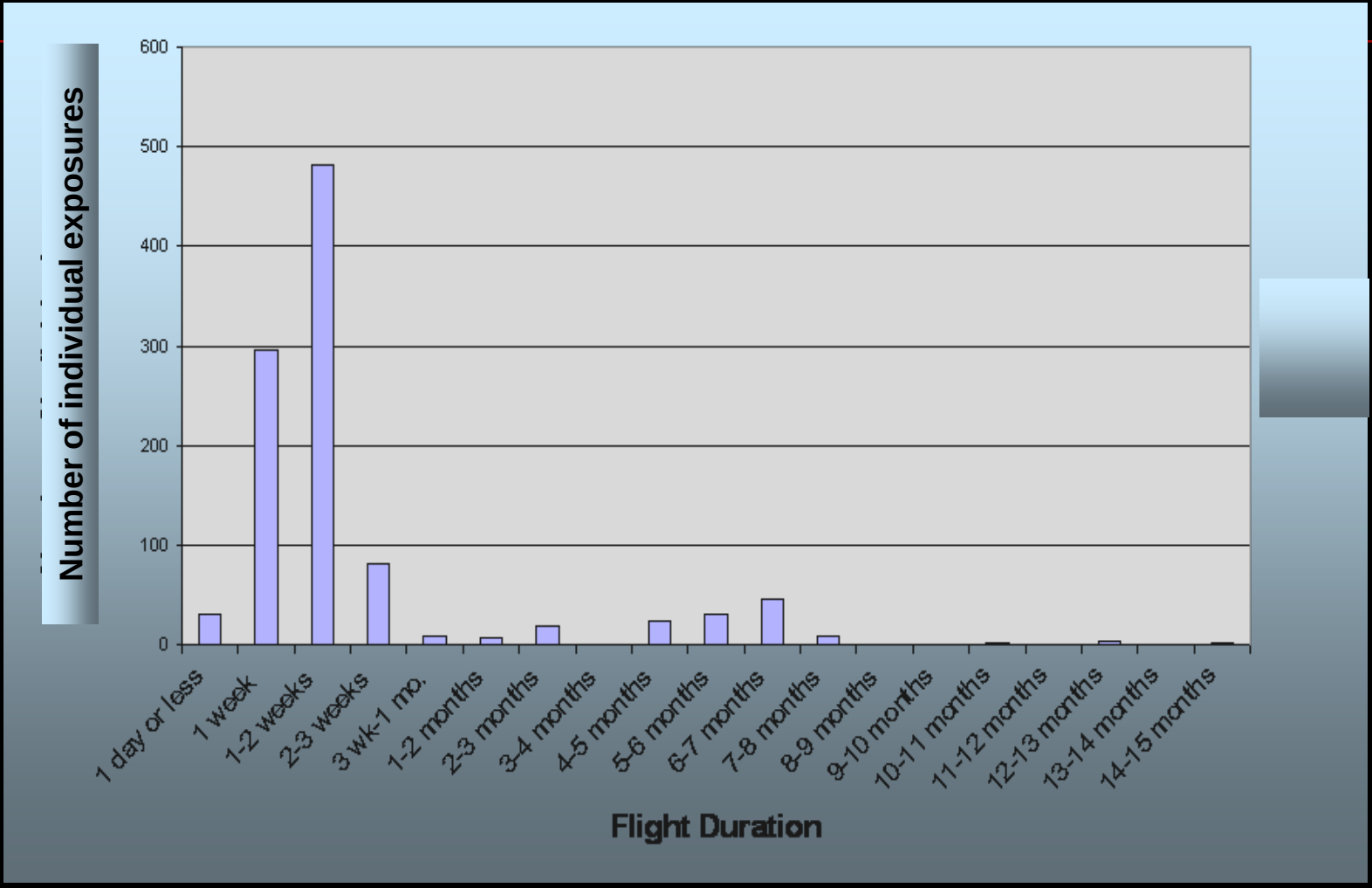
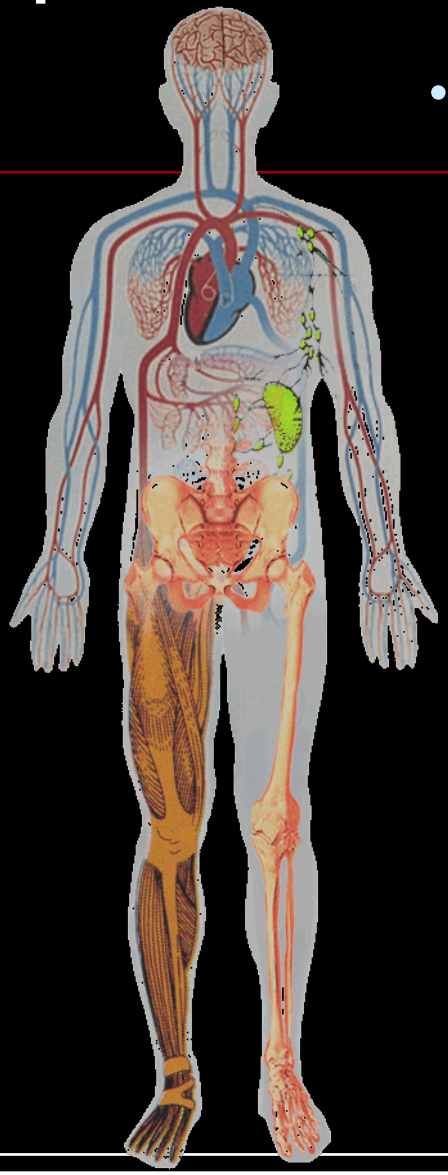
Human Spaceflight Experience



Human Response to Spaceflight

Astronauts experience a spectrum of adaptations in flight and postflight

Balance disorders
Cardiovascular deconditioning
Decreased immune function
Muscle atrophy
Bone loss



- 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**

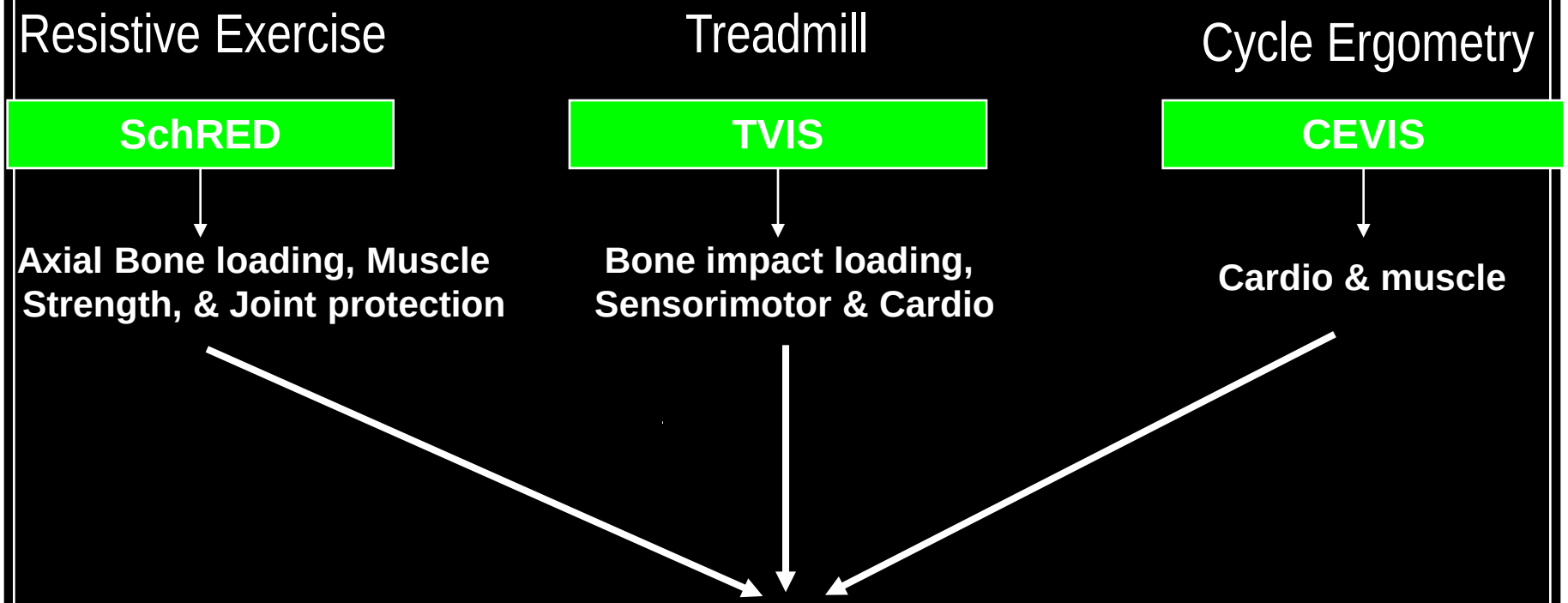
ISS Expeditions 1-16

- 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

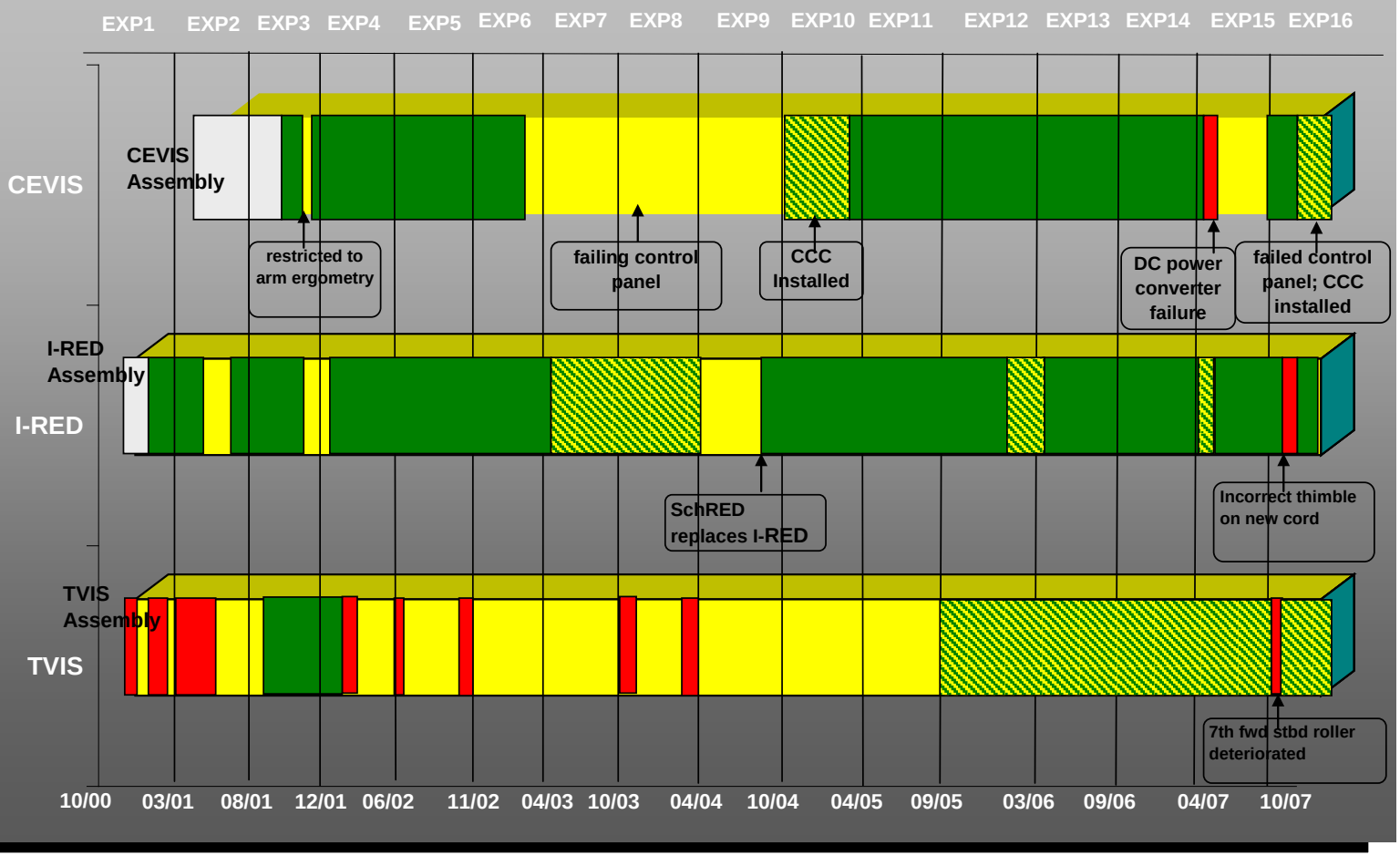
Exercise Countermeasures System Elements



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

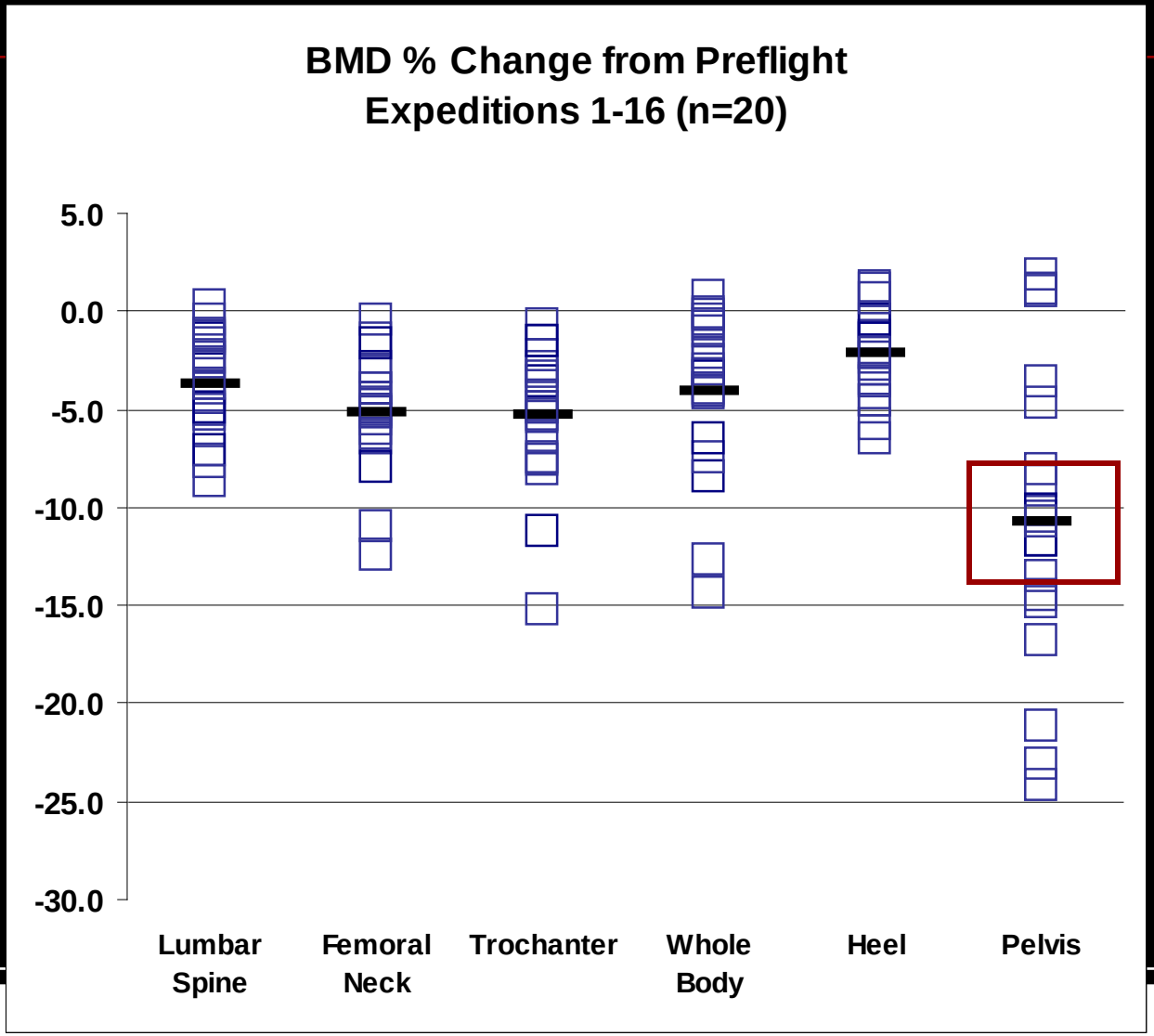
ISS Exercise Hardware Availability Timeline



Biomedical Data

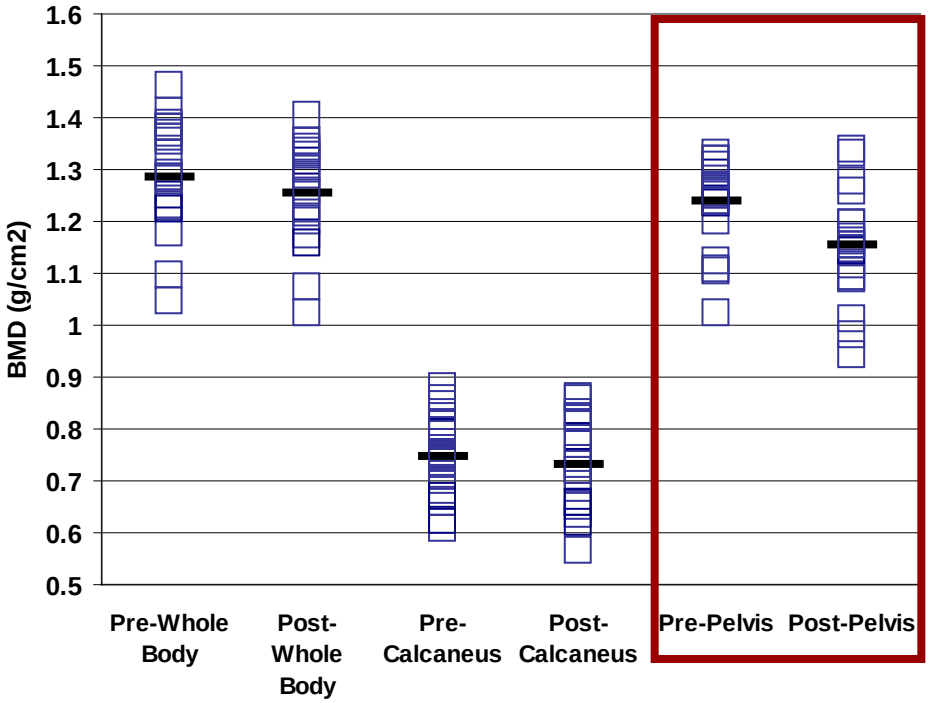
- Data Collected via Medical Requirements
- Assessments of:
  - Bone
  - Aerobic Fitness
  - Functional Fitness

Decreased Bone Mineral Density

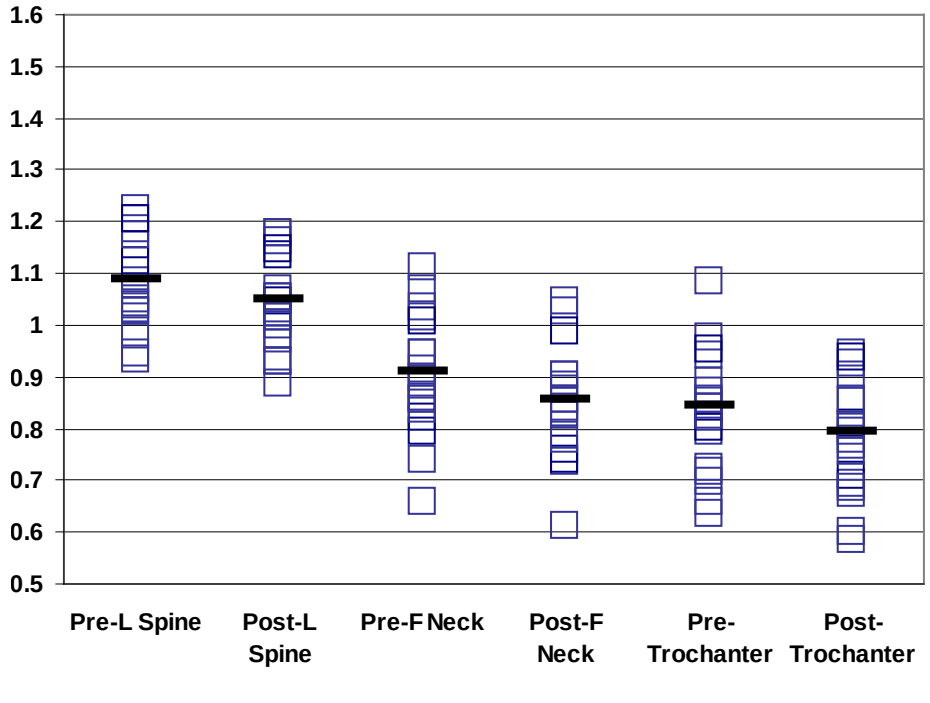


Decreased Bone Mineral Density

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

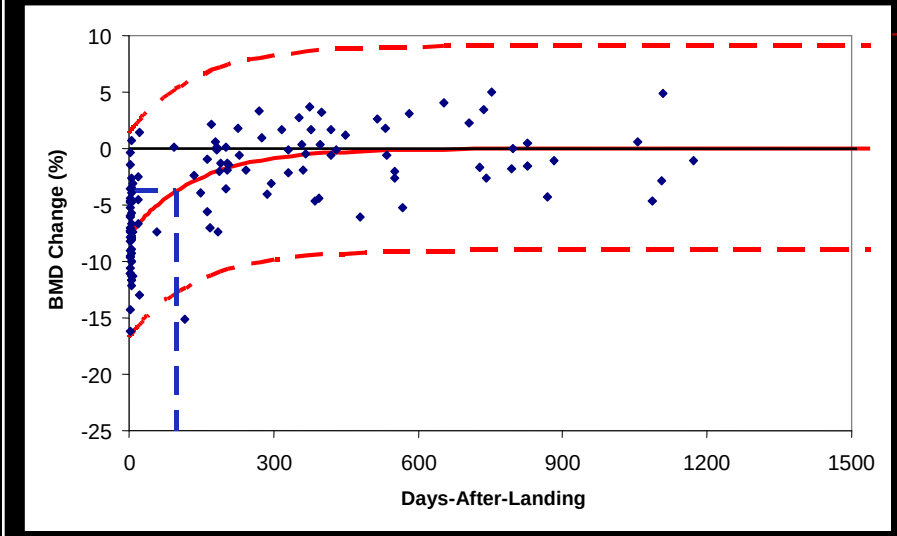


Pre and Post Bone Mineral Density- I
Expeditions 1-16 (n=20)

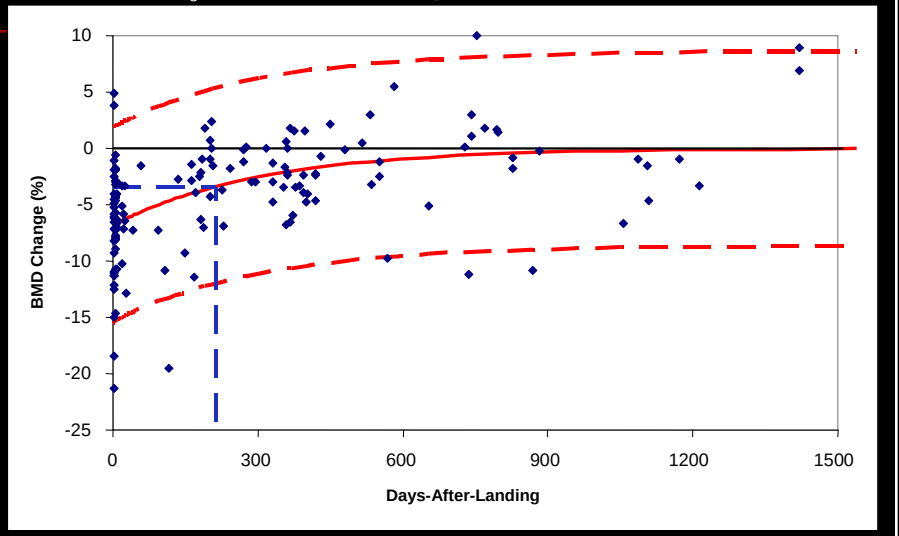


Bone Mineral Density Recovery

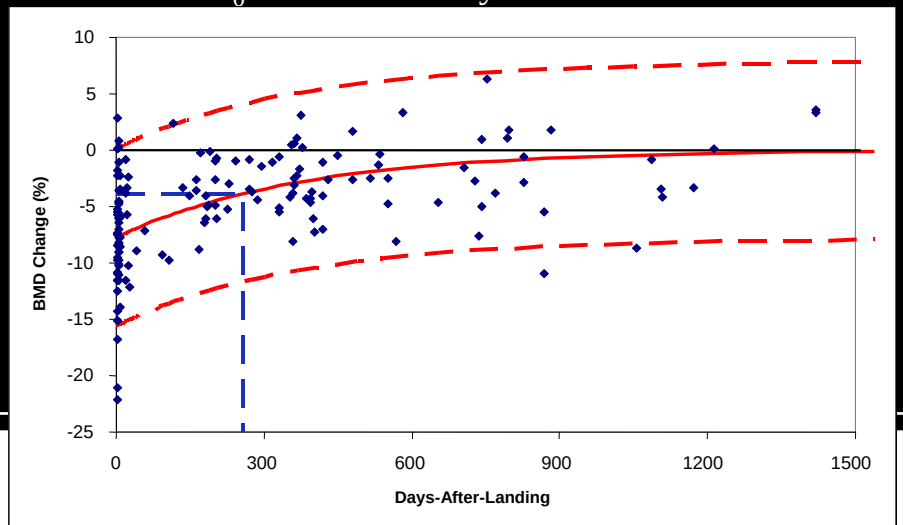
Pelvis
$Loss_0$=7.7% Recovery Half-life=97 d



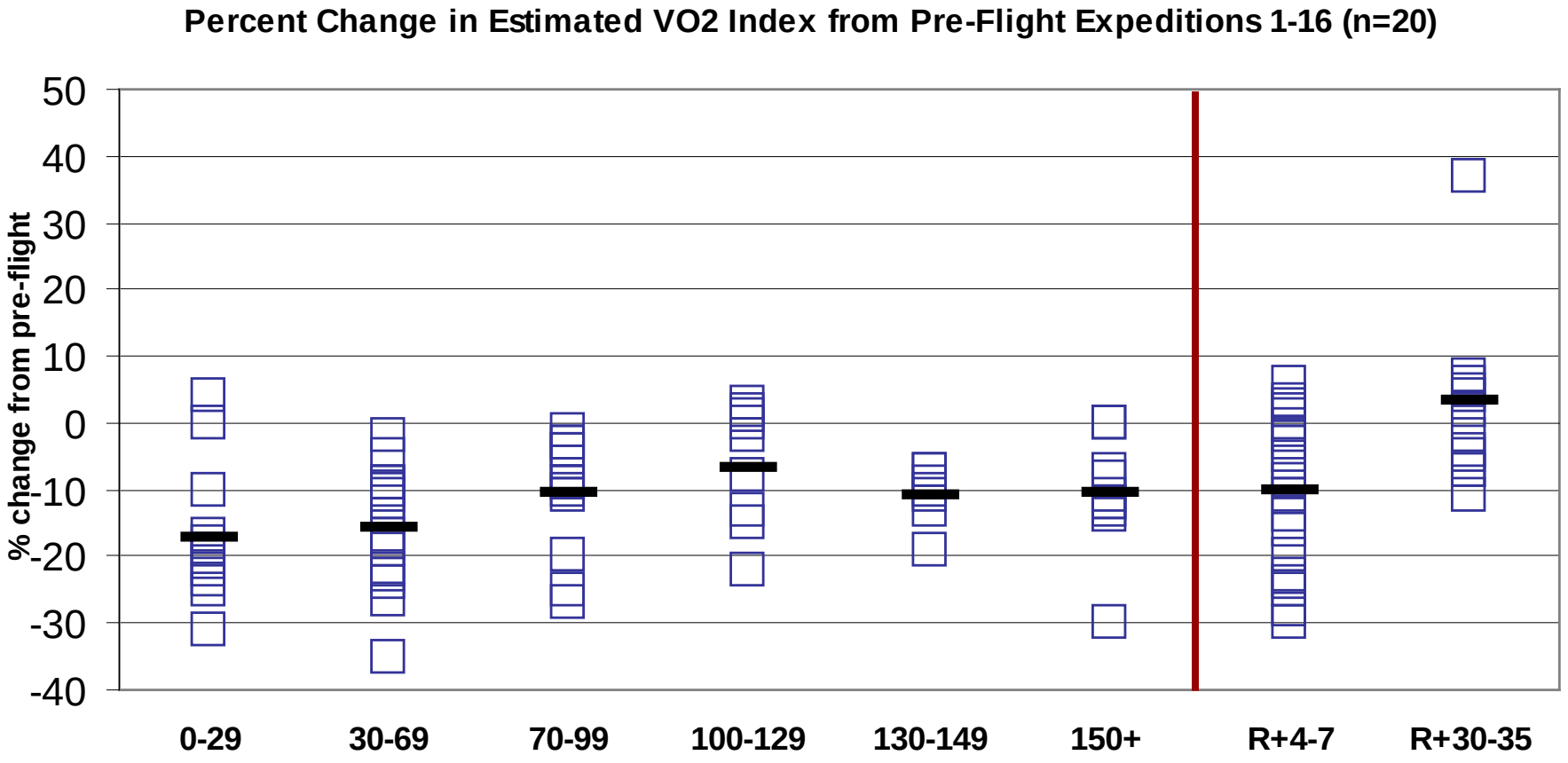
Femoral Neck
$Loss_0$=6.8% Recovery Half-life=211 d



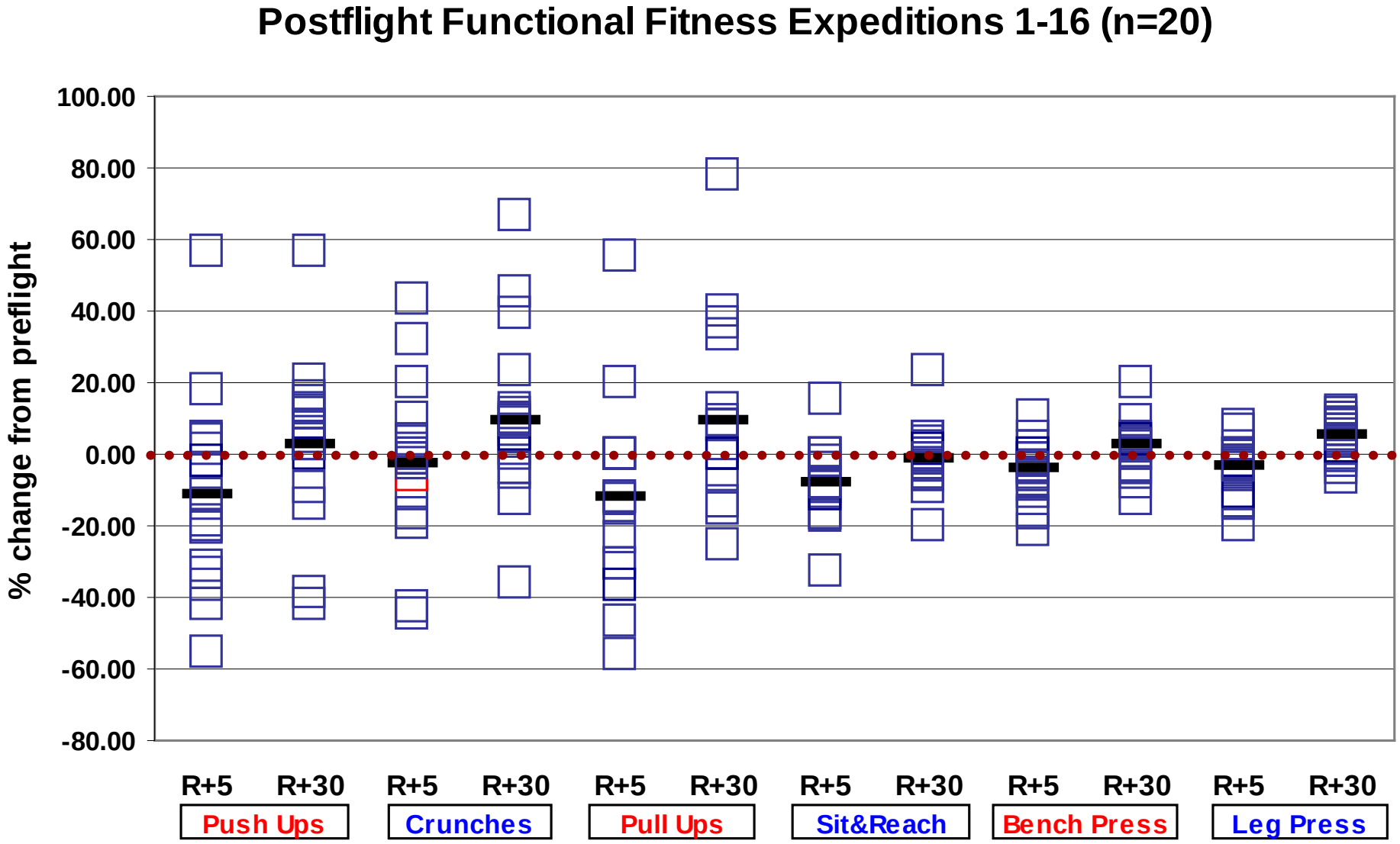
Trochanter
$Loss_0$=7.8% Recovery Half-life=255 d



Estimated In-flight and Post-flight Aerobic Capacity



Recovery of Functional Fitness



Back Up Slides

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.