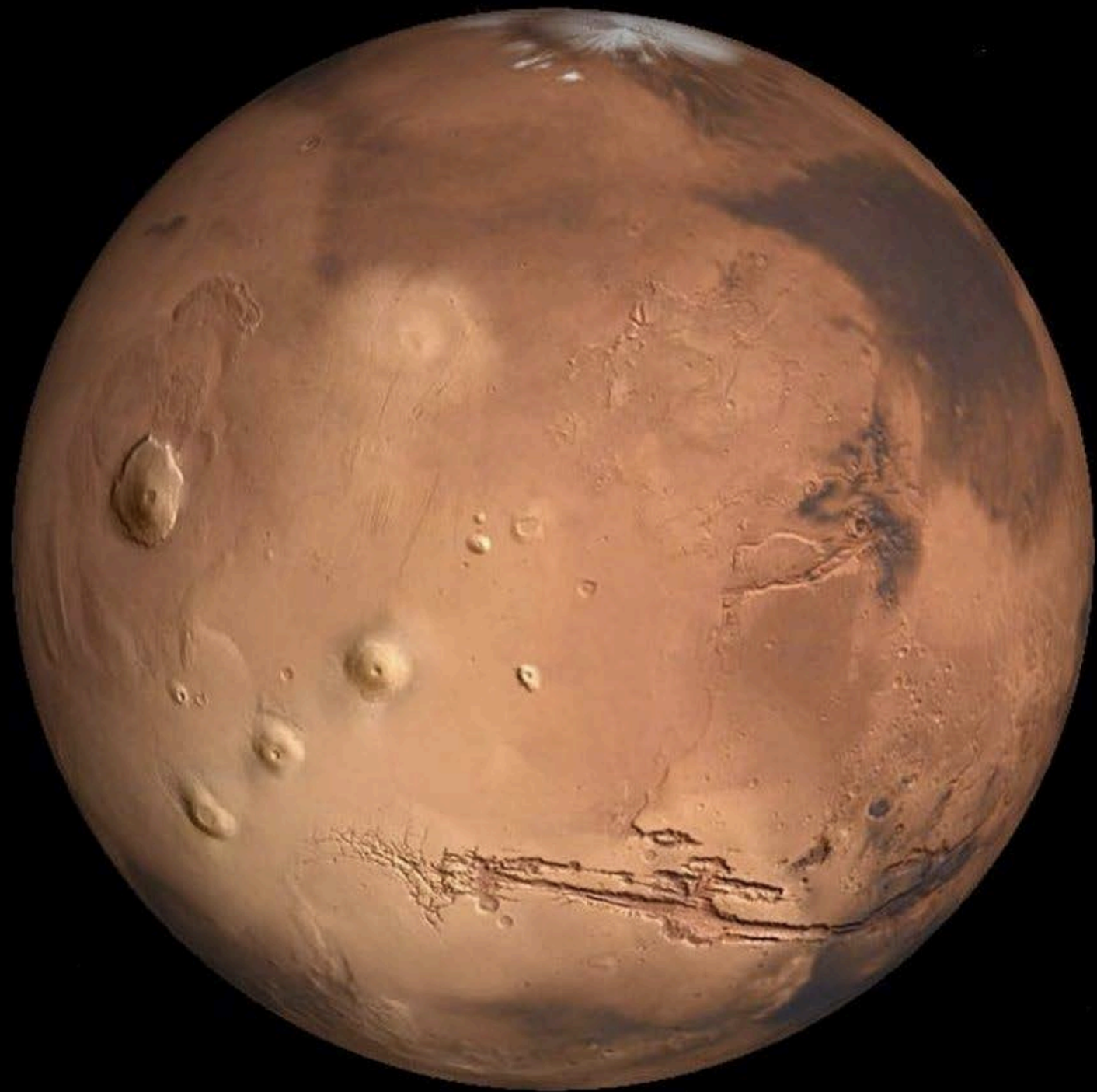


Multisystem Review of Inter-Individual Variability among Astronauts

Jennifer Fogarty, PhD
Human Research Program
Deputy Chief Scientist
September 6th, 2016





HRP: Research to Enable Space Exploration



Human travelers to Mars will experience unprecedented physiological, environmental, and psychosocial challenges that could lead to significant health & performance decrements in the absence of effective mitigation strategies.

Success of any human mission to Mars will hinge on the mission designers' ability to develop and implement such strategies.

NASA's Human Research Program is responsible for identifying those strategies.




Radiation

Altered Gravity Fields

Hostile Closed Environment

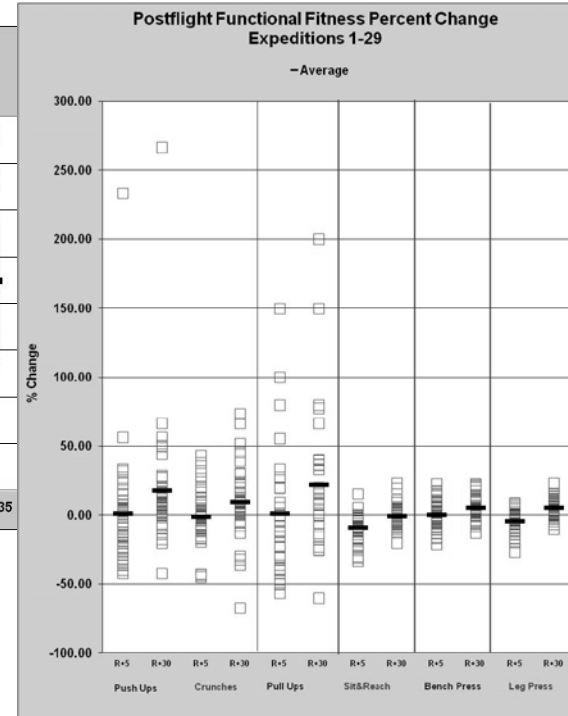
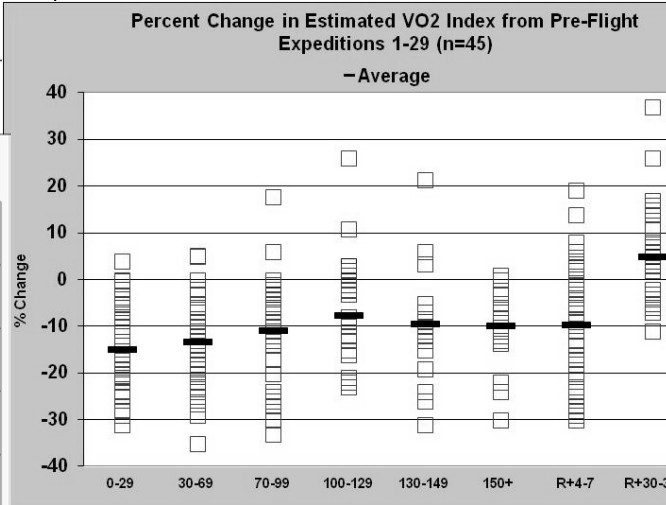
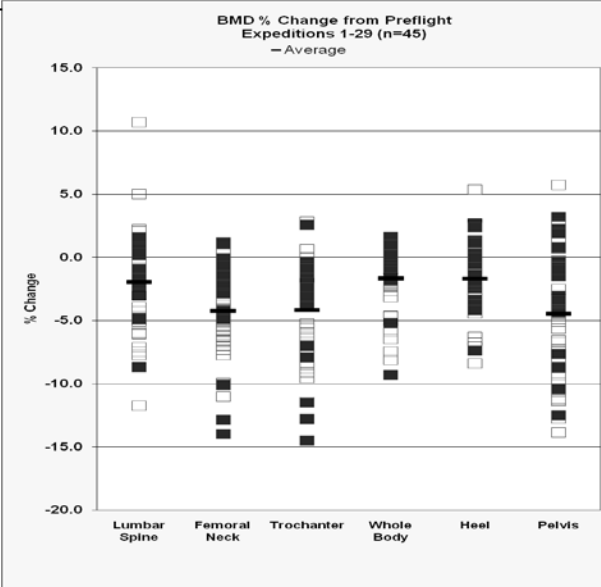
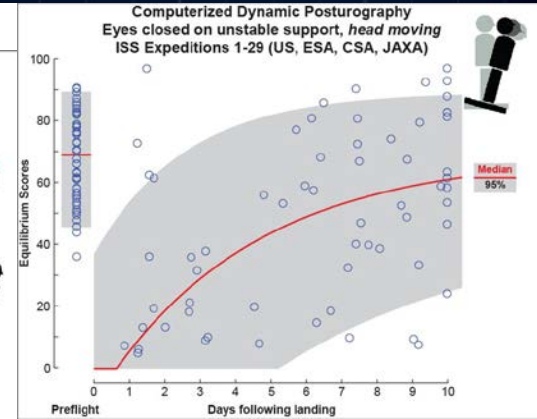
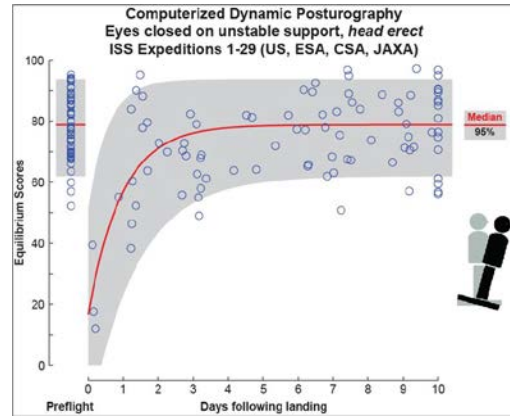
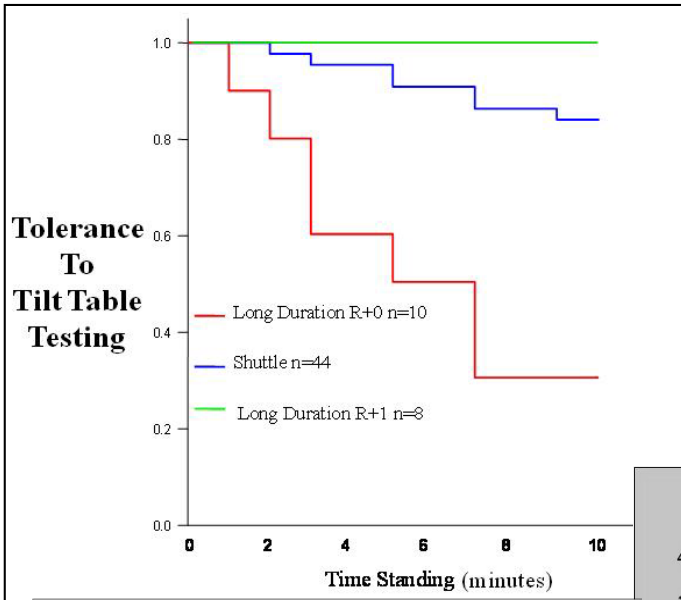
Isolation/Confinement

Distance from Earth

 Earth

International Space Station

Medical Requirements collect physiological, medical and environmental data



Data can be used to assess the individual or the population

Bone Density ↔ Fracture Risk



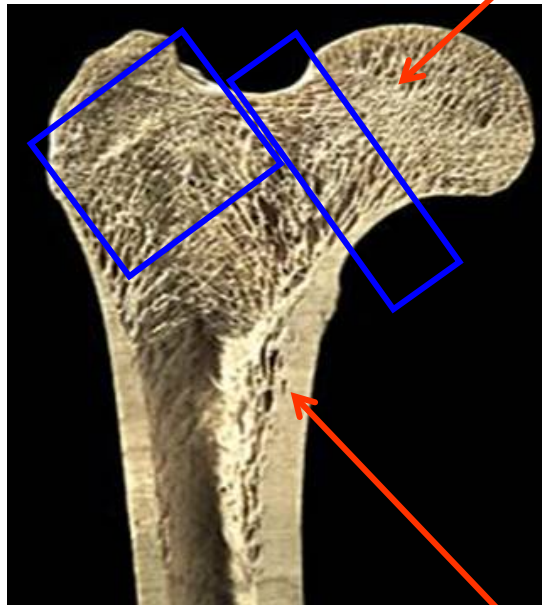
Bone compartments or bone types

Cancellous "Spongy" Bone/Trabecular Bone

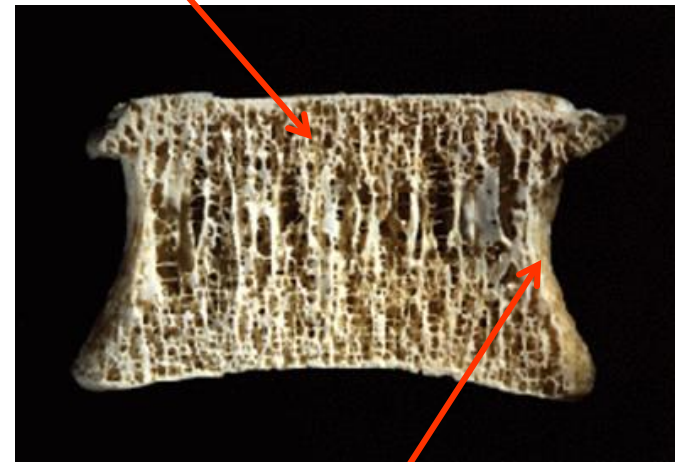
PROXIMAL FEMUR

Trochanter

Femoral Neck



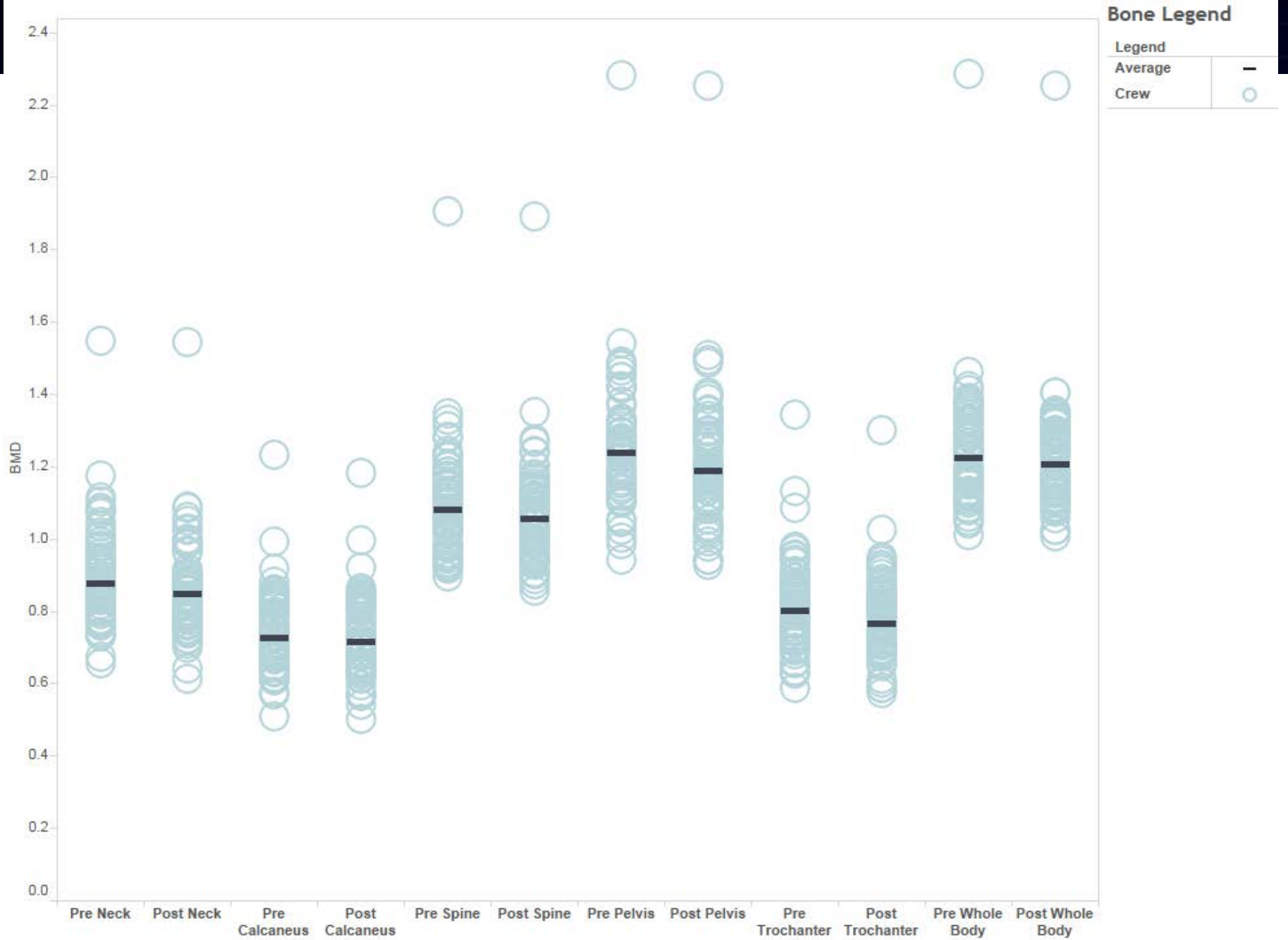
VERTEBRAL BODY



Cortical Bone/ "Compact Bone"

Sources: L. Mosekilde; SL Bonnick; P Crompton

Pre and Post BMD values



Absolute Changes in BMD

Bone Legend

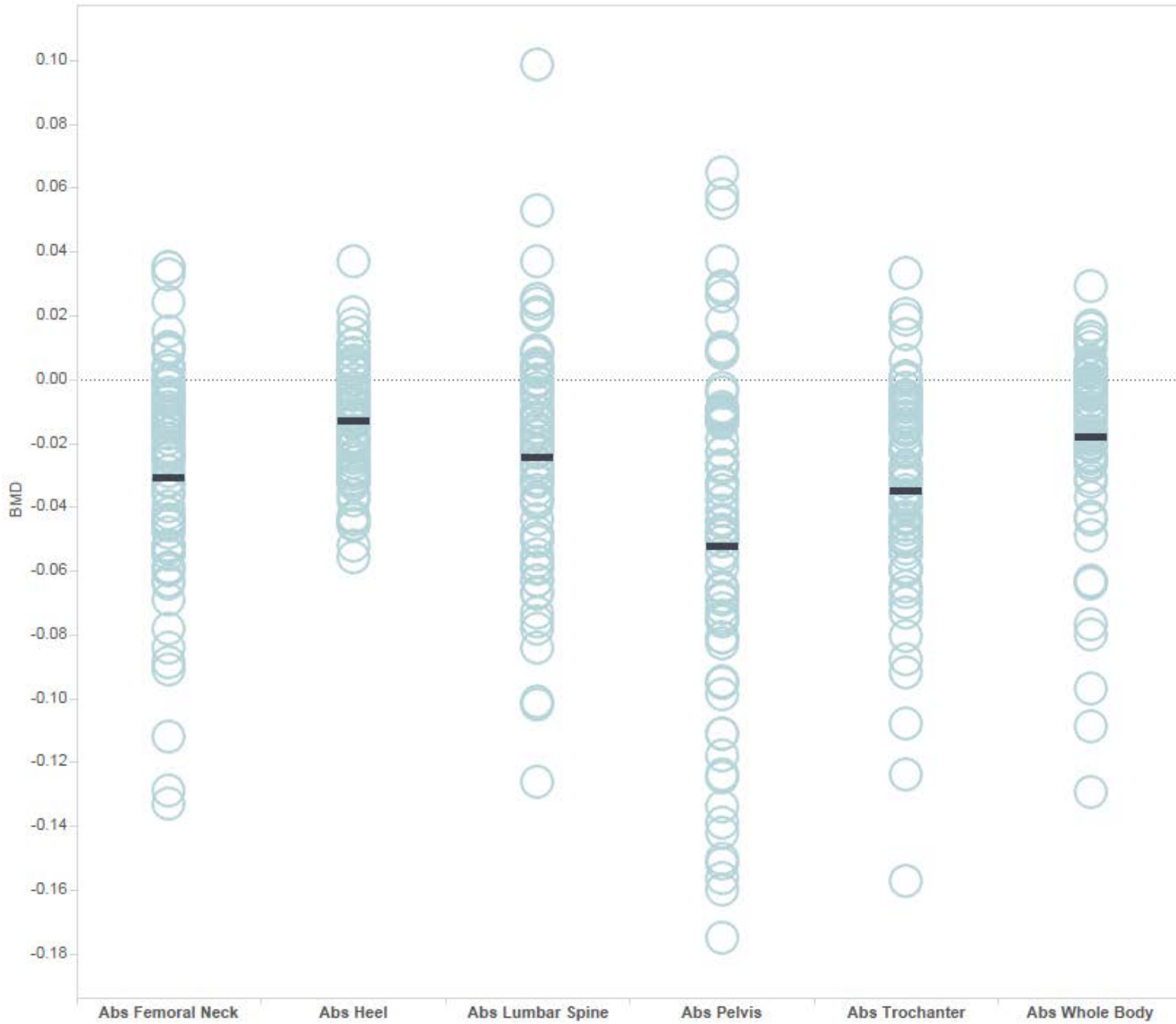
Legend

Average

Crew

—

○



Exercise in Space: Now and in the Future

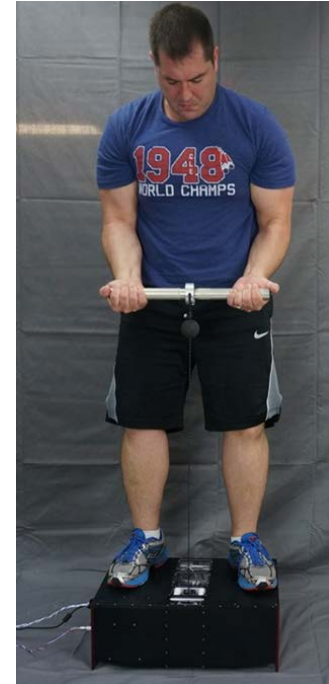
Variability in Usage and Outcomes



Advanced Resistive Exercise Device (ARED)



Treadmill (TVIS)



Curl (Resistive example)



Cycle Ergometer (CEVIS)

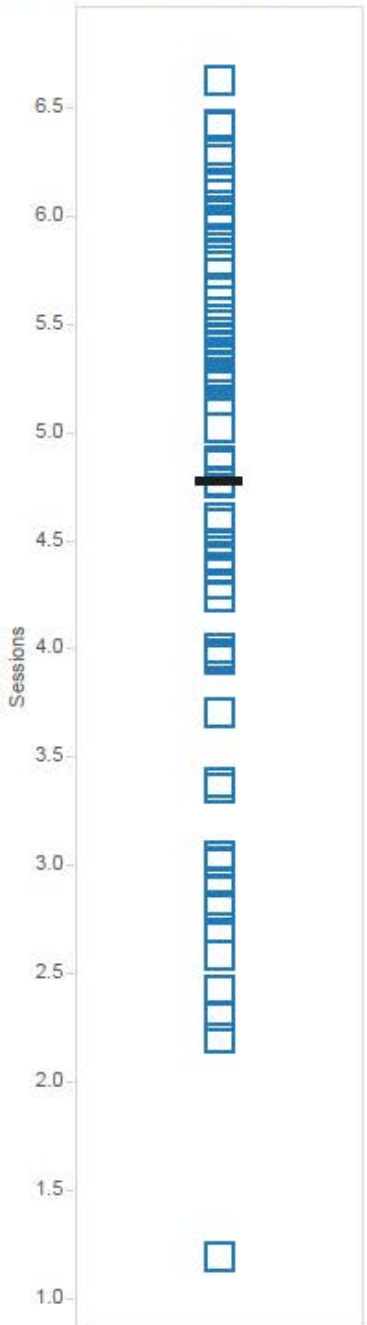


Rowing (Aerobic)

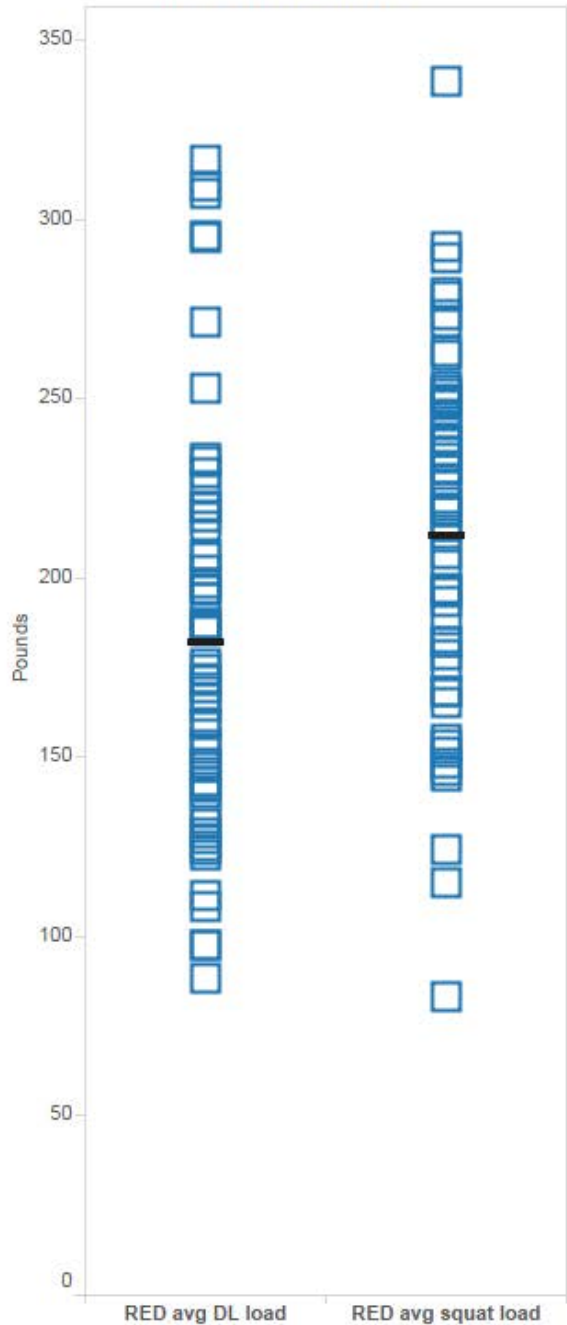
RED Metrics

Highlight Crewmember
Average
Crew

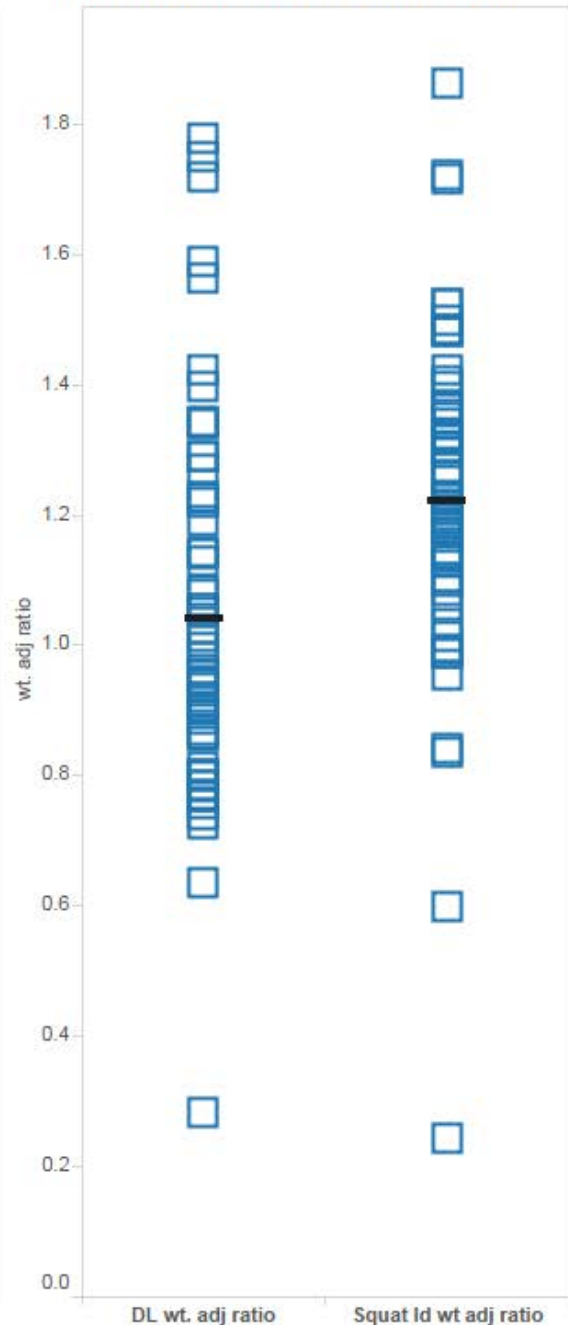
RED Sessions per Week



RED Average Loads



RED Body Weight Adjusted Ratio

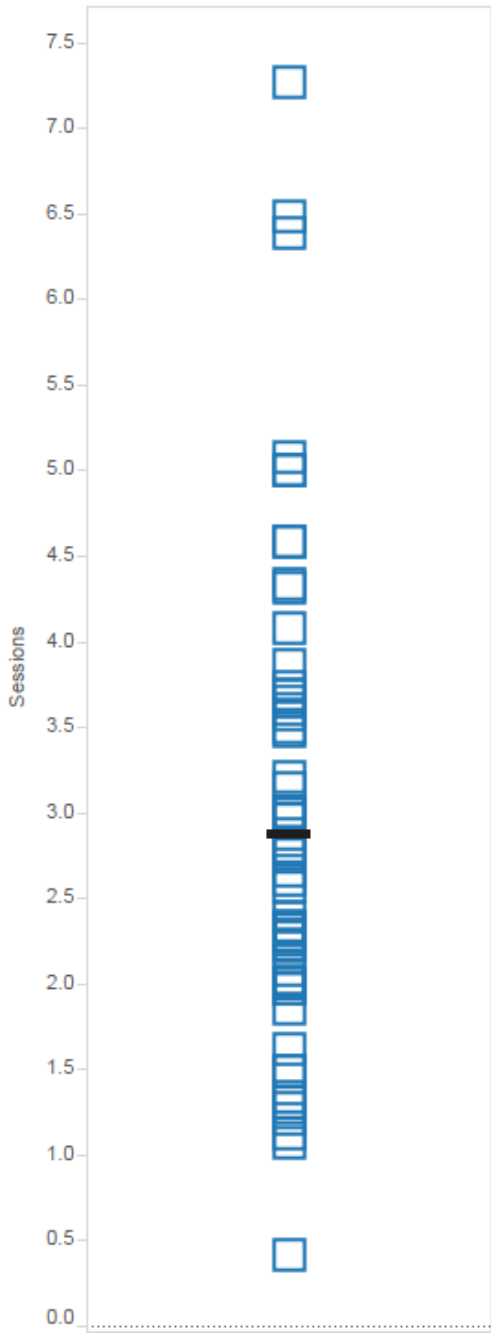


Resistive Exercise Device (RED)

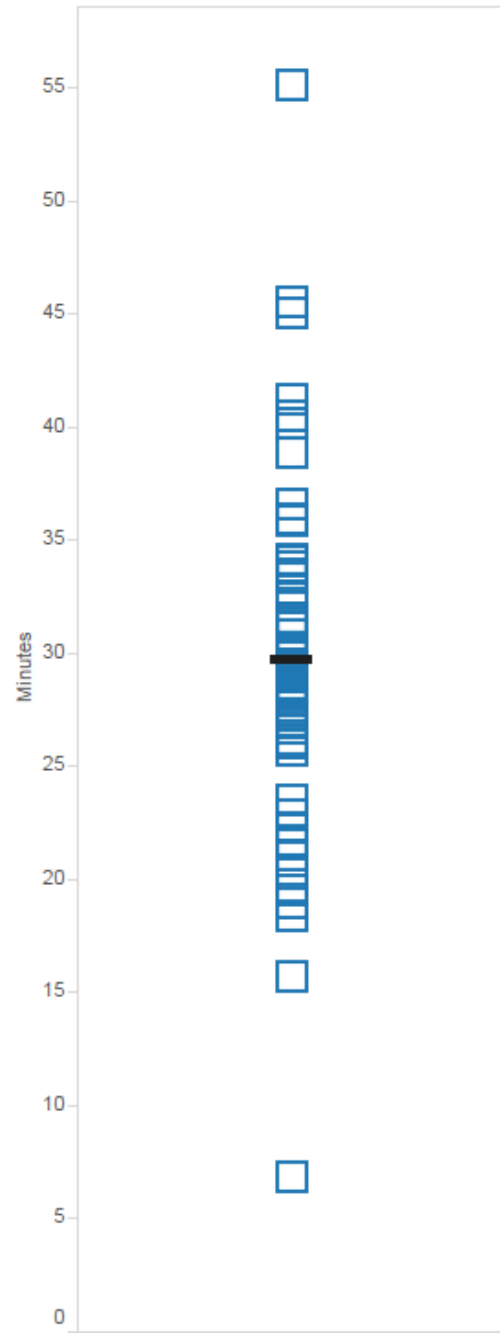
CEVIS Metrics

Highlight Crewmember
Average
Crew

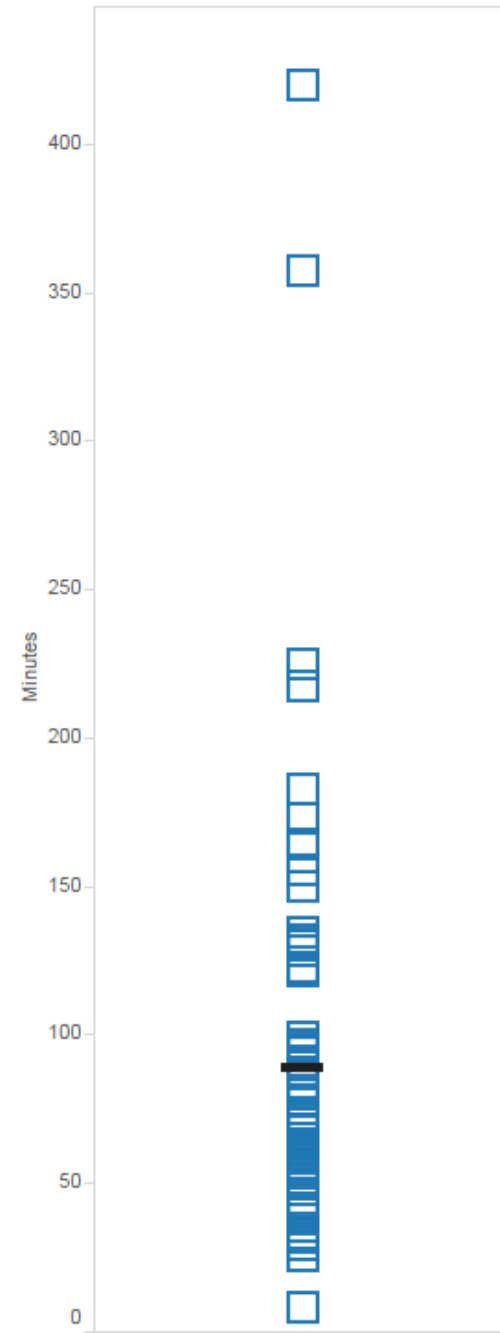
CEVIS Sessions per Week



CEVIS AVG session time



CEVIS Minutes per Week

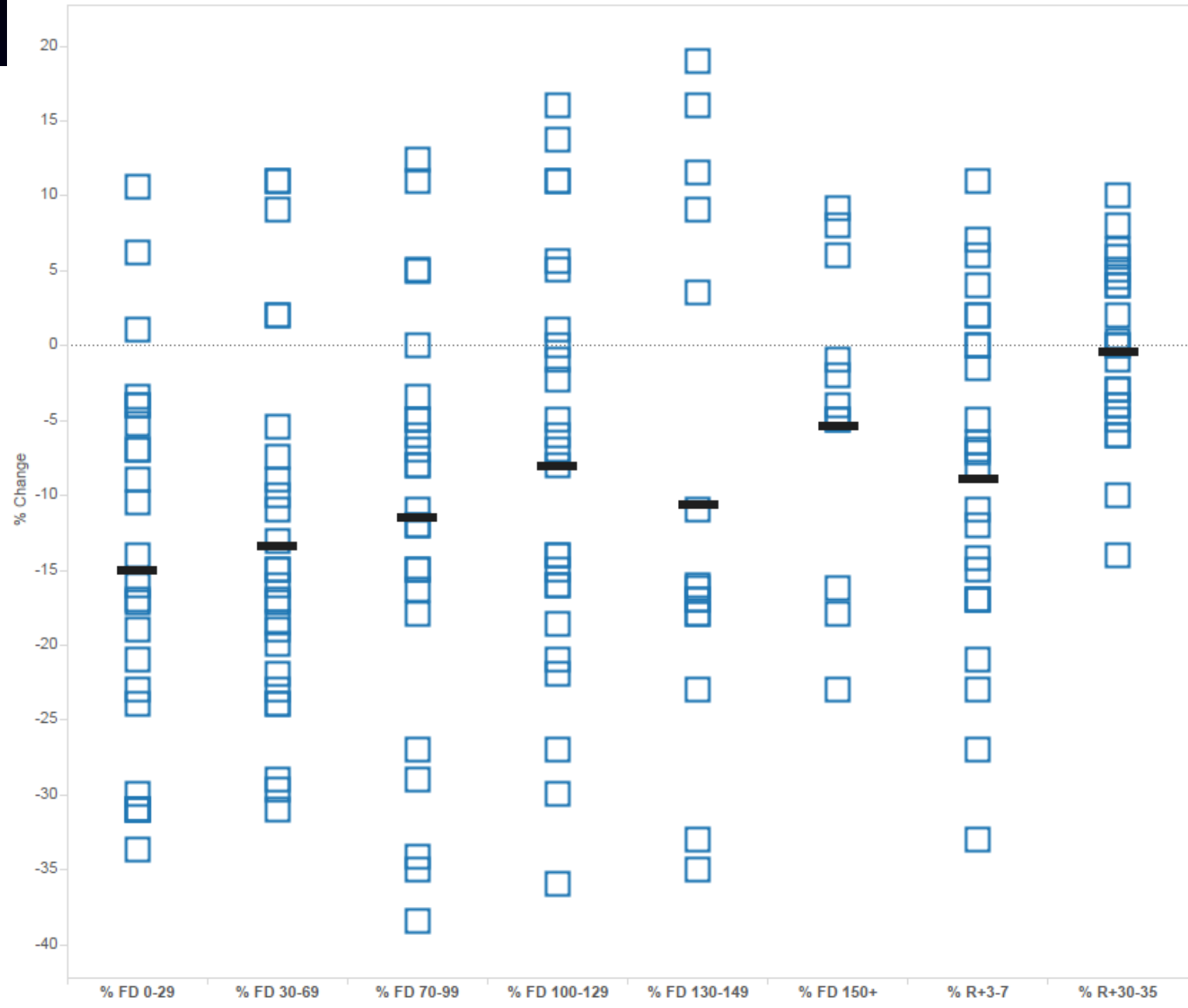


Cycle Ergometry with Vibration Isolation System

% Change in VO2

Highlight Crewmember
Average
Crew

% Change from Preflight in Actual VO2



Aerobic Capacity Testing

BMM

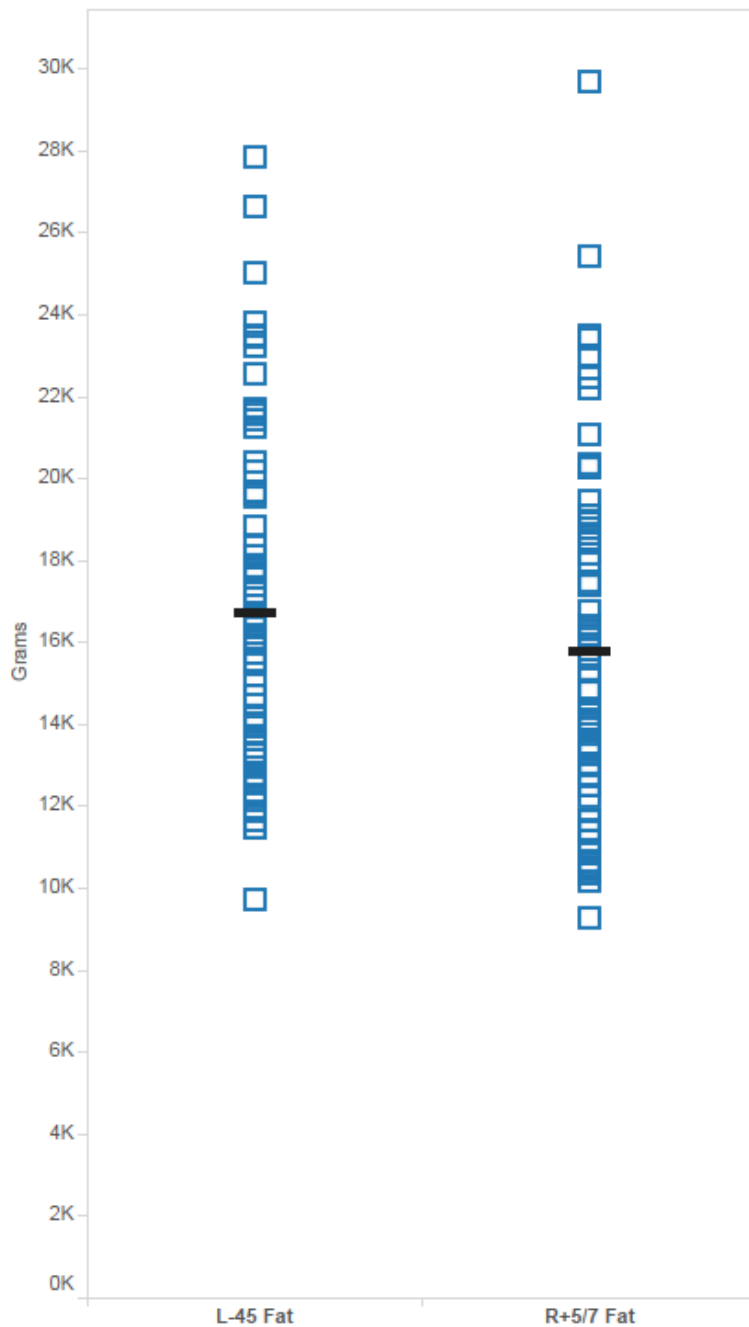
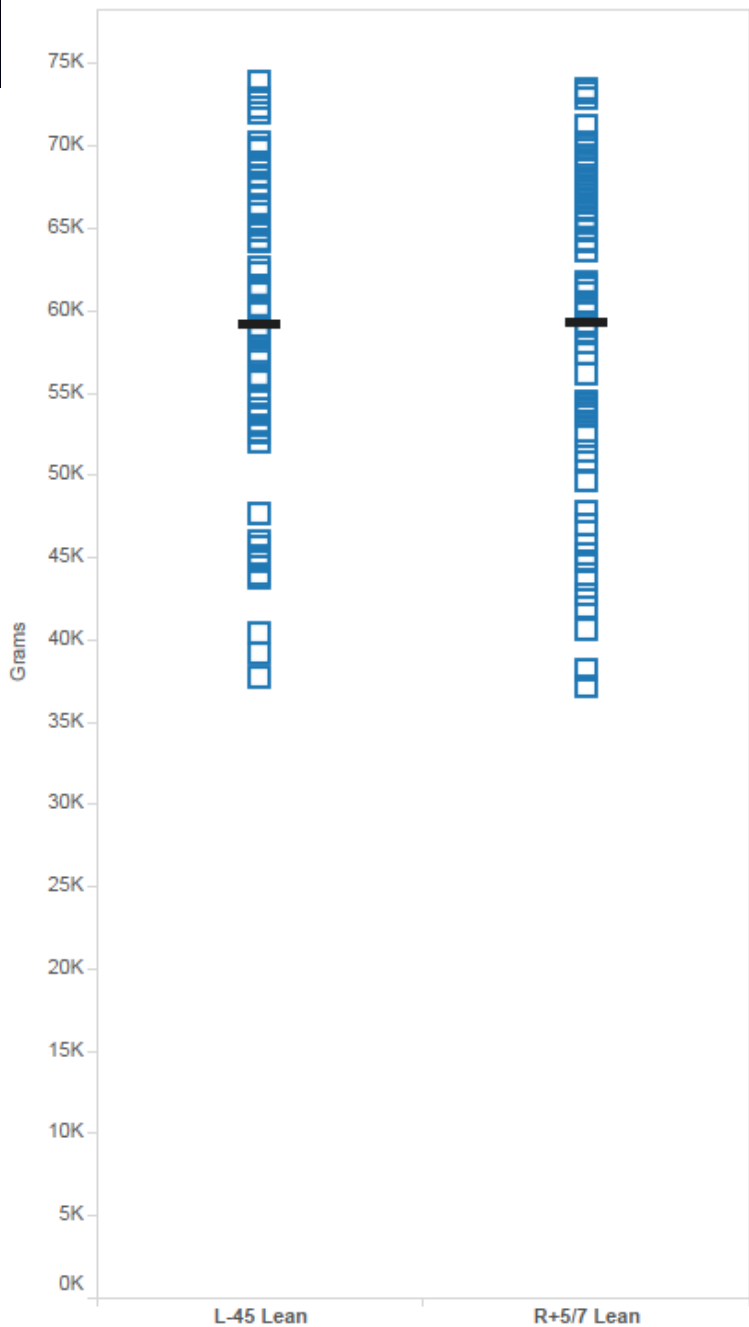
Highlight Crewmember

Average

Crew

BMM Lean

BMM Fat



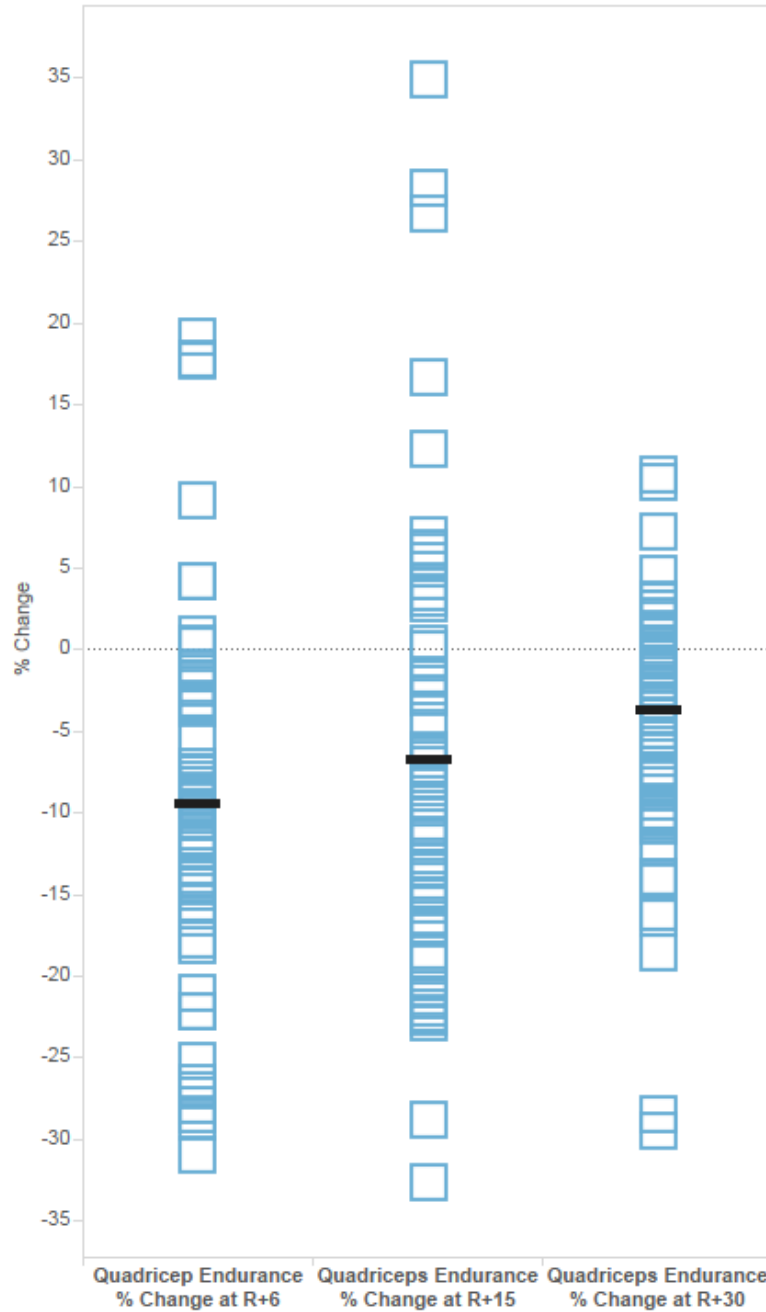
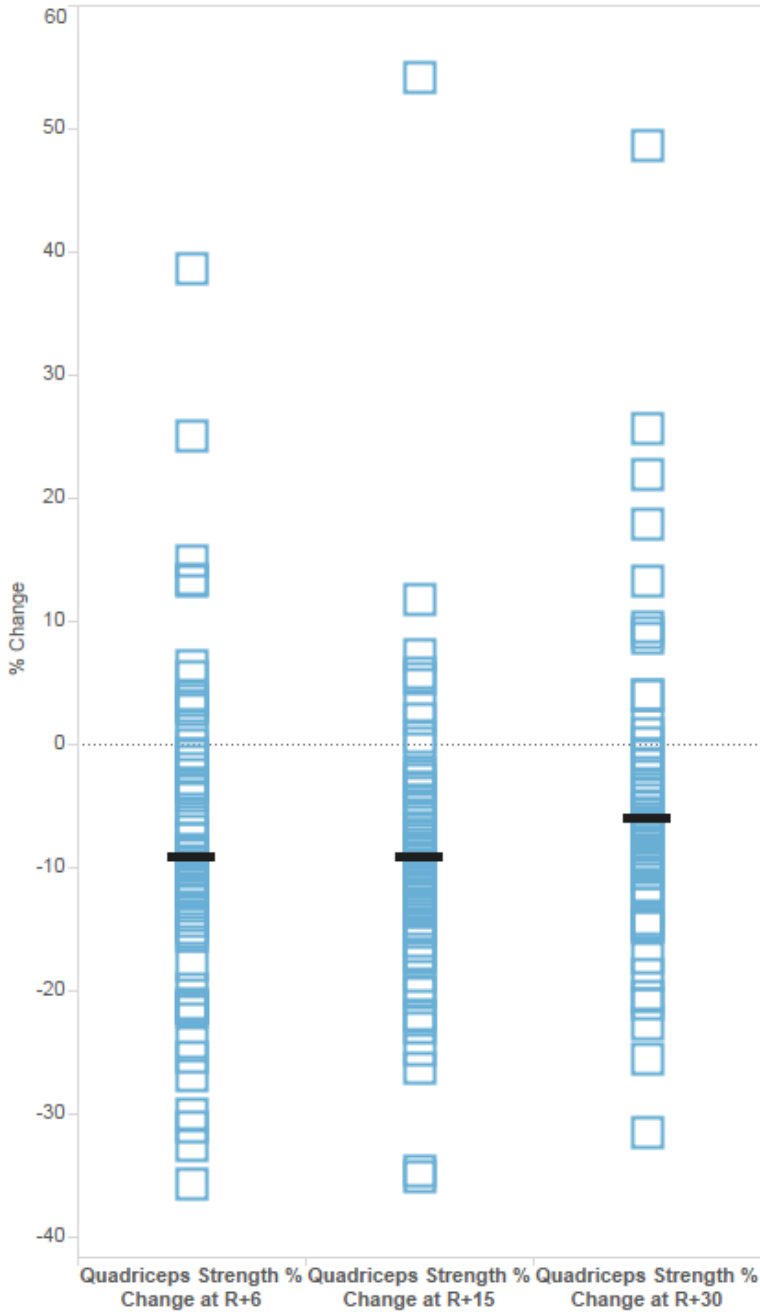
Body Mass Measurement via DXA

Quadricep % Change

Highlight Crewmember
Average
Crew

Quadriceps Strength % Change

Quadriceps Endurance % Change

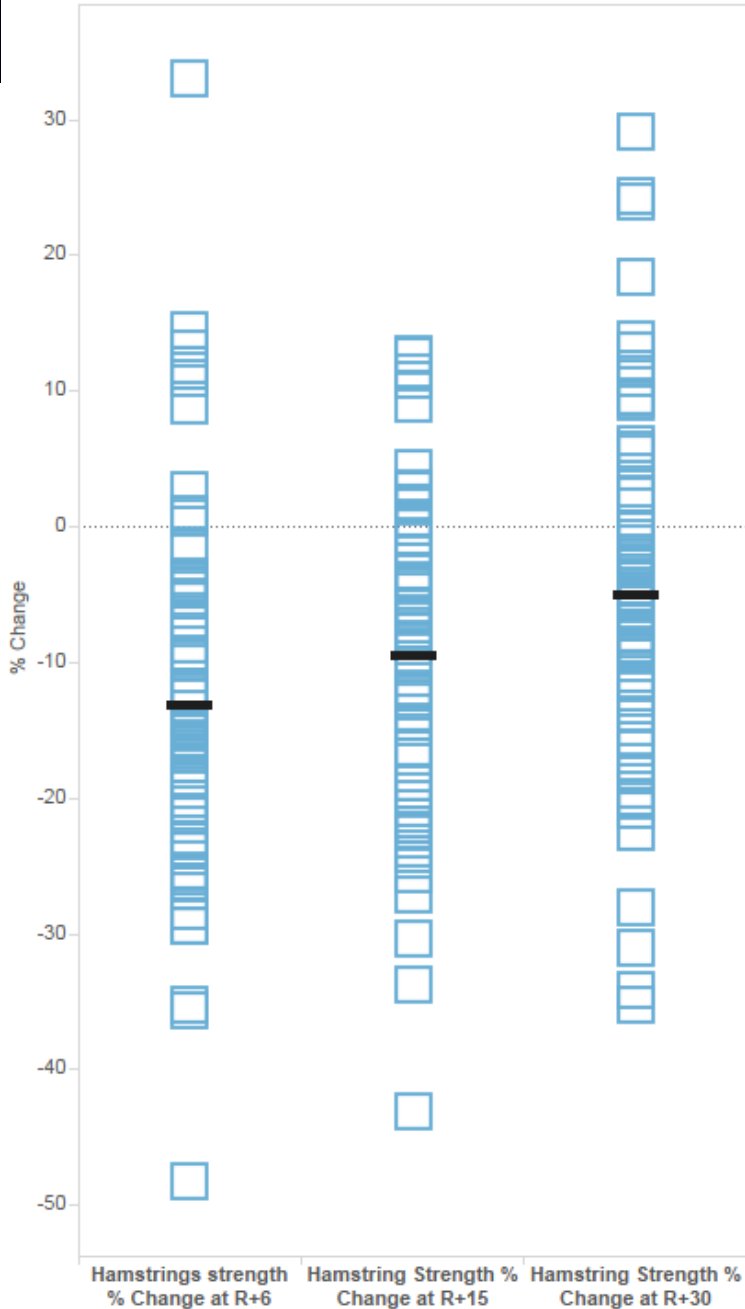


Isokinetic Testing

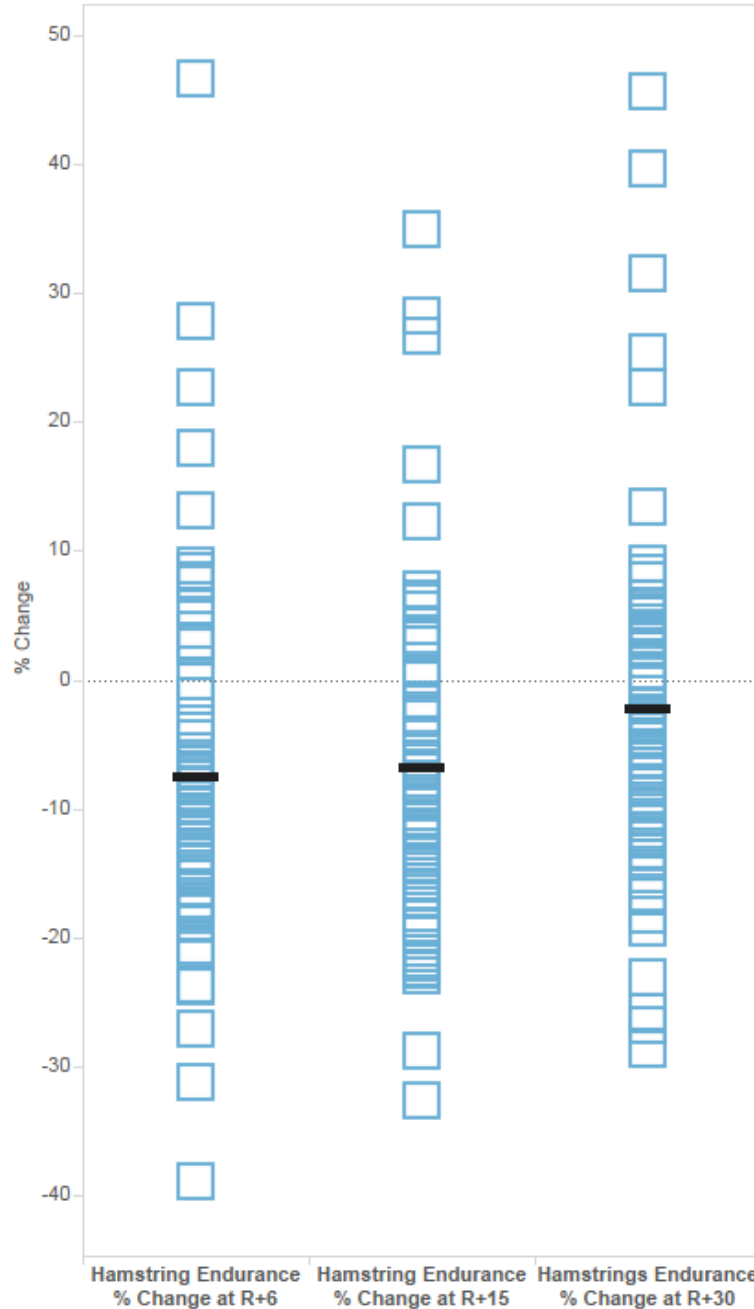
Hamstring % Change

Highlight Crewmember
Average
Crew

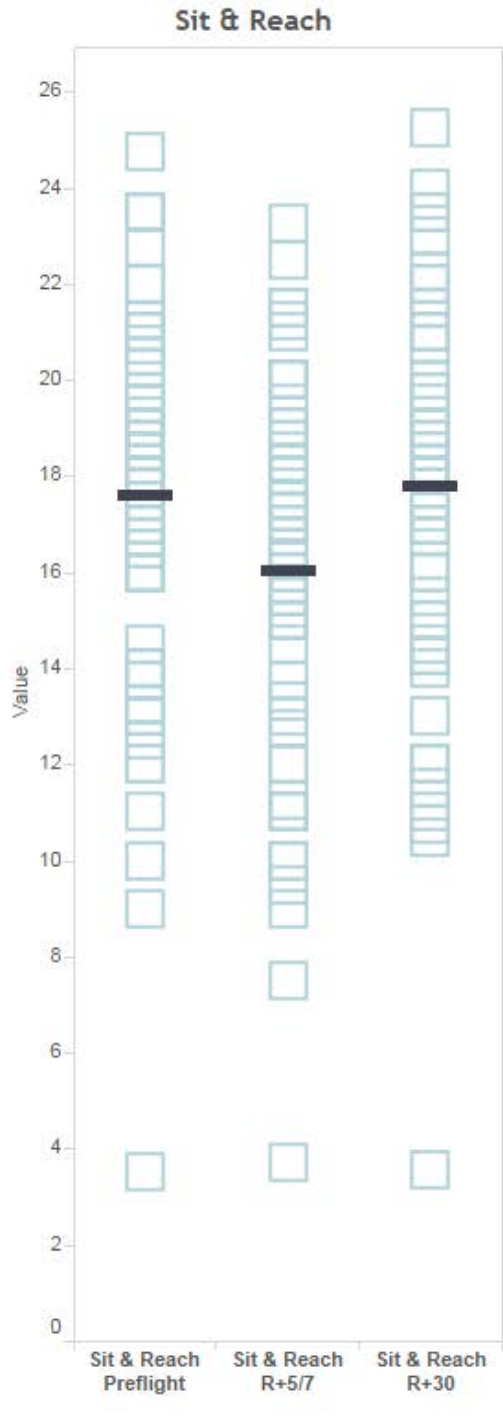
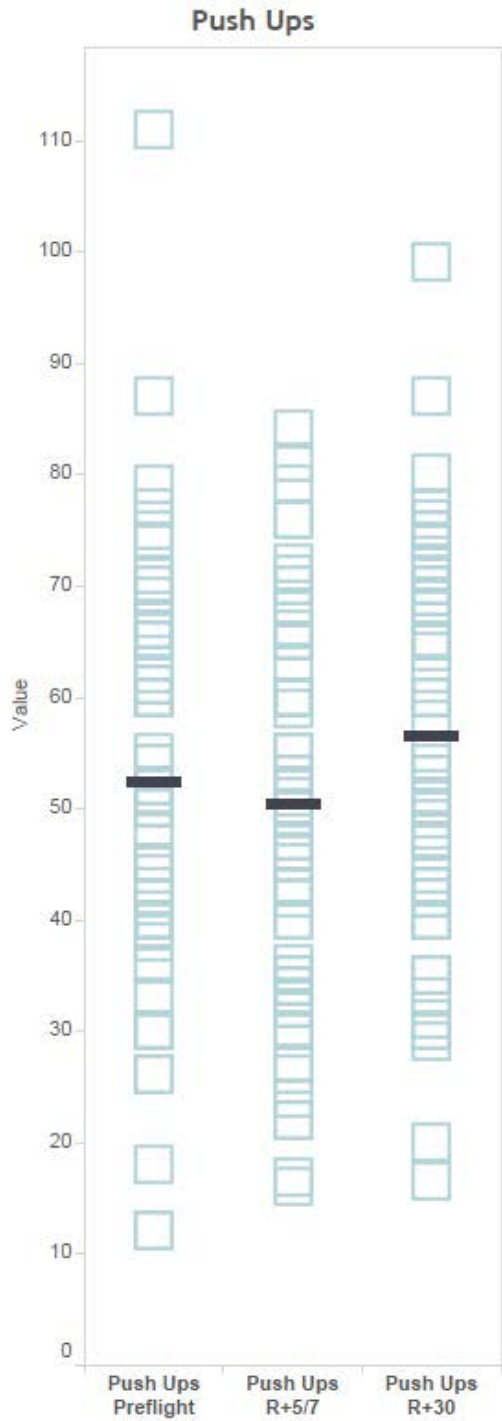
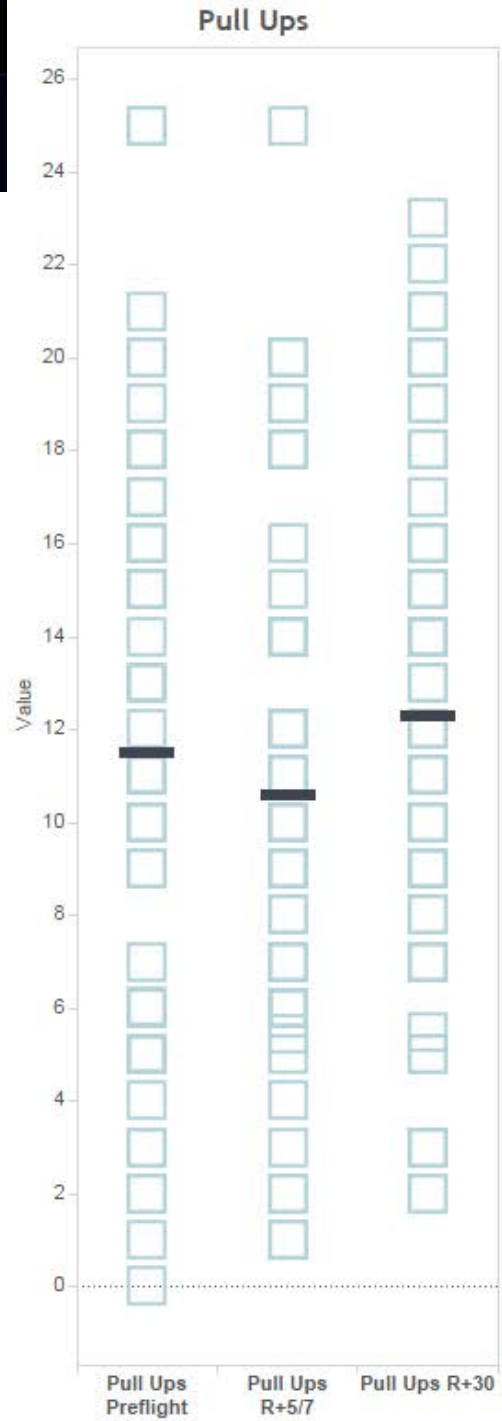
Hamstrings Strength % Change



Hamstrings Endurance % Change

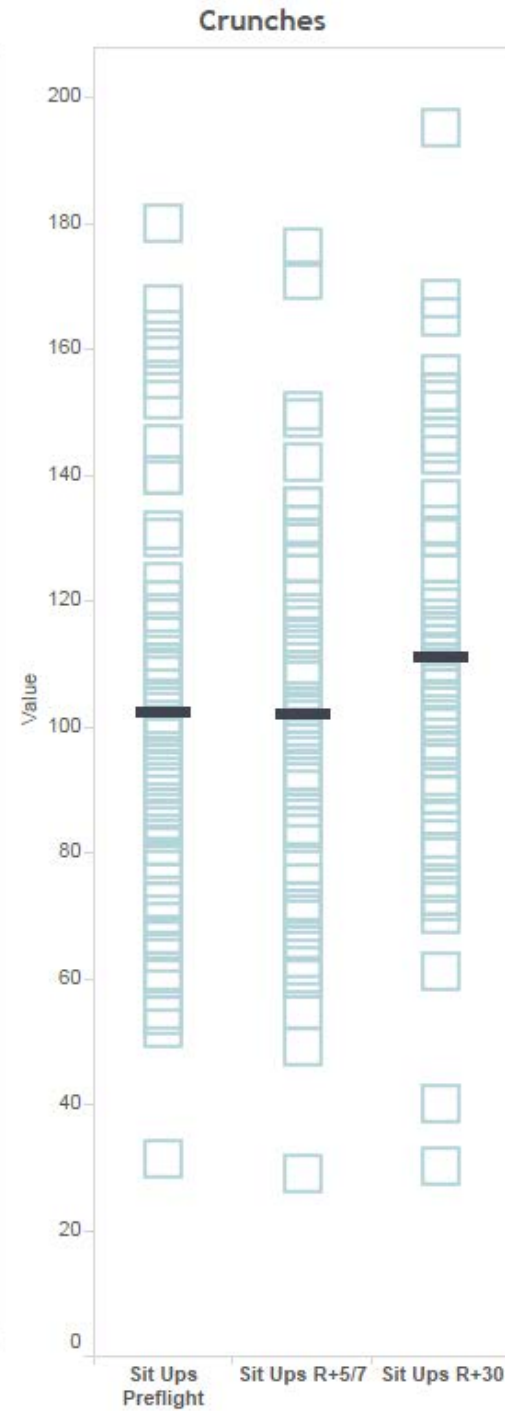
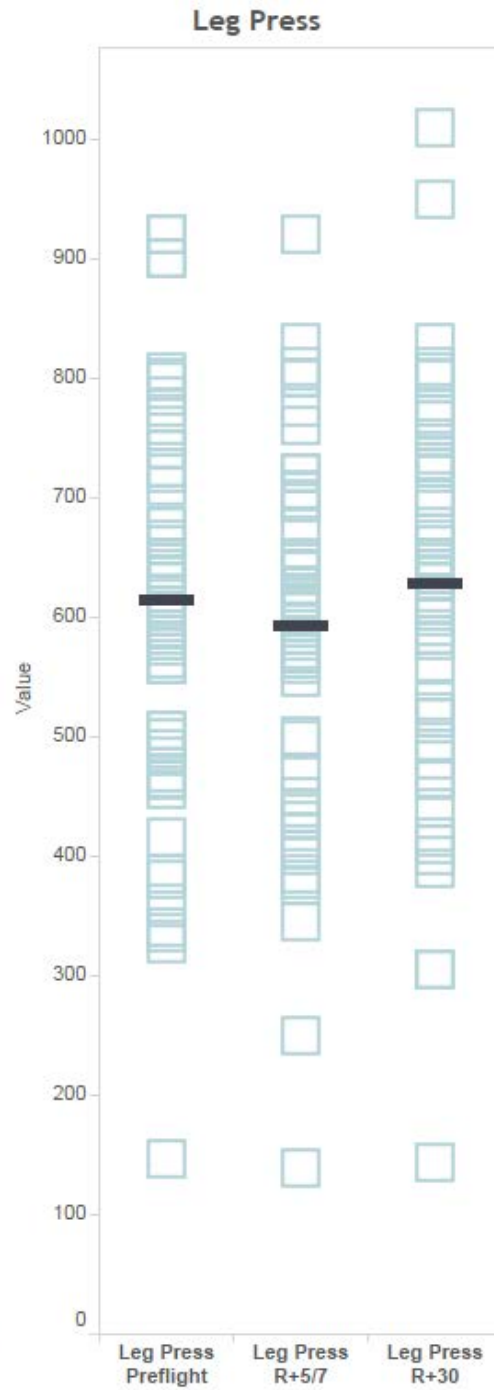
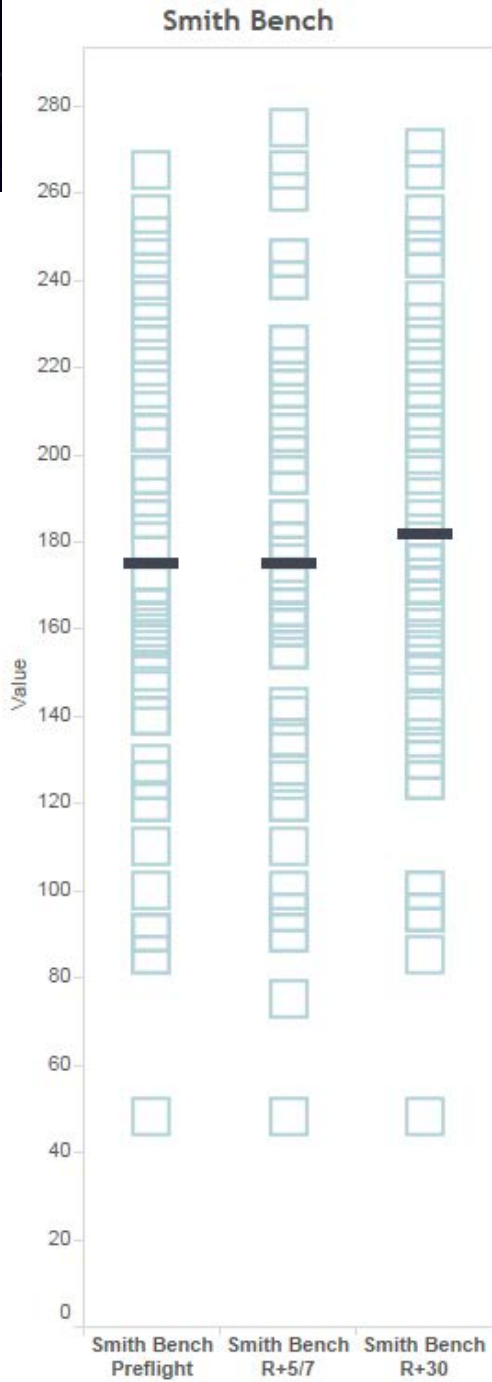


Isokinetic Testing



Highlight Crewmember
Average
Crew

Functional Fitness Testing

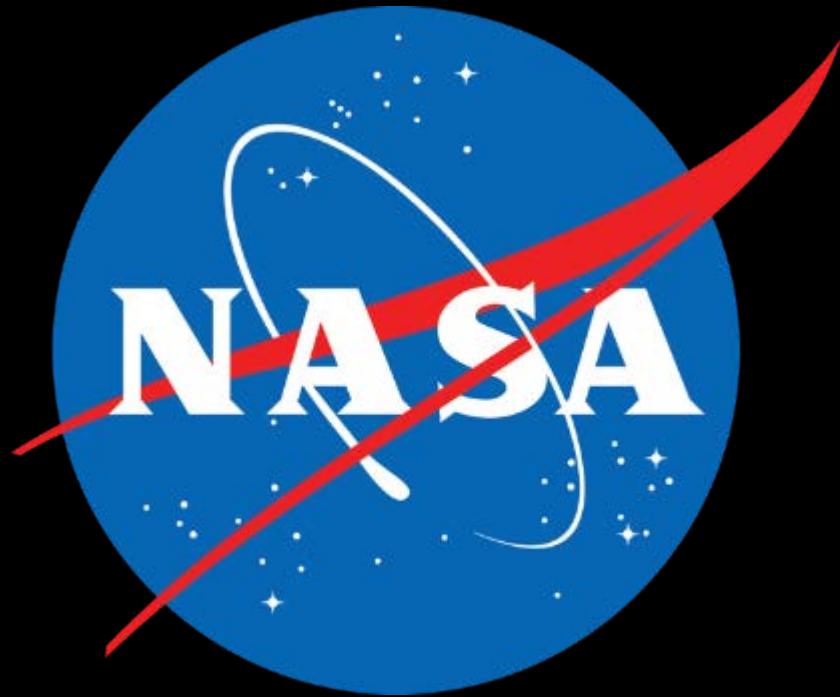


Highlight Crewmember
Average
Crew

Functional Fitness Testing

A dark, monochromatic landscape. The bottom portion of the image shows a silhouette of a mountain range against a slightly lighter, dark grey background. The upper portion is a uniform dark grey. In the upper left quadrant, there is a small white arrow pointing towards the upper left, followed by the word "Earth" in a white, sans-serif font.

Earth



Important Back Up Information



ISS Expeditions 1- 47

- **USOS Crewmember Descriptions**
 - ❖ 59 males: 43 NASA (8*stayed 2x); 16 IP's- non RSA (1 stayed 2x)
 - ❖ 12 females: 11 NASA(2 stayed 2x);1 ESA;
 - ❖ Average age: 47.8 years (U.S. average)
- **Average length of mission: 166.55 days** (non-Russian)
 - ❖ 340 days (longest) to 48 days (shortest)
 - * Includes 1 who stayed on ISS and MIR



Acknowledgements

- **Harlan Evans- Bone Mineral Density and Mass Measurement Data**
- **Roxanne Buxton and Andrea Hanson- In-flight Exercise and Rehabilitation Data**
- **Kirk English- Isokinetics Data**
- **Mark Guilliams, David Hoellen, Bruce Nieschwitz- Functional Fitness Data**