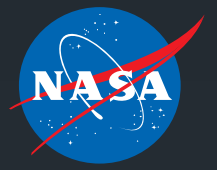
National Aeronautics and Space Administration



Quantification of Inflight Physical Changes: Anthropometry and Neutral Body Posture (Body Measures)

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Background

- NASA, currently, does not have sufficient in-flight anthropometric data to assess the impact of physical body shape and size changes on suit sizing and for interior workplace design on future vehicles.
- Current information is limited and is based on SkyLab data with few subjects (3).
- Recent study on Spinal Elongation (an HRP study in 2009-2011) was primarily focused on Orion seat configuration (microgravity effects on seated height).

Background

- Suit fit issues in microgravity
  - NASA suit engineers, the EVA Project Office, and the MOD trainers have identified that suit fit in microgravity could become an issue as evidenced during a recent incident on-board the ISS.
  - It has also been noted that crewmembers often need to adjust their suit sizing once they are in orbit.
  - This adjustment could be due to microgravity effects on body shape and size (anthropometry) and posture.
  - Extended hiatus between NBL training and EVA for ISS crewmembers – may decrease familiarity.
- An understanding of how the body changes in microgravity is thus necessary to ensure optimal crew performance, fit, and comfort in space.

Objective

- The goal of this study is to gather preliminary data to better understand the magnitude and variability of microgravity changes on the body.
  - To do this, we aim to gather and document microgravity effects on body measurements.
    - Lengths
    - Breadths
    - Depths
    - Circumferences
    - Joint angles
  - To determine if/how the Neutral Body Posture (NBP) is influenced by the above factors.

- This will be the first time these proposed measures are collected in space. It is anticipated that body measurements will change due to microgravity and fluid shifts.
- This data is important so that the changes that may occur during long-duration space flight can be identified and applied to suit fit, suit sizing, workstation design, etc. for future missions in order to prevent injury and reduce crew time for altering or adjusting suits, workstations, etc.

Objective

- Three activities
  - Activity 1: Anthropometric photographs/measurements
    - Collect digital photographs to measure heights, breadths, depths, lengths
    - Collect circumferences using tape measure
    - Collect measurements using Anthropometer & 3D whole body laser scanner (ground only)
  - Activity 2: NBP
    - Collect video to determine posture and joint angles (in-flight only)
  - Activity 3: Weight/Body Mass Measurement

Study Description: Activity 1

Activity 1: Anthropometric Photographs/ Measurements

- Collect pre-, in-, and post-flight
- Collect anthropometric measurements using:
  - Anthropometer (ground only)
  - Tape measure
  - Digital still photographs
  - 3D body scanner (ground only)
- Collect two photographs per posture for three specific postures in front of ISS rack
  - front facing posture (front)
  - side with right arm extended 45°(side 1)
  - side with right arm abducted 90°(side 2)
- Collect 3D body scan in same postures as photographs with markers (ground only)

Study Description: Activity 2

Activity 2: Neutral Body Posture (NBP)

- Collect video of blindfolded subject performing NBP task.
  - Consists of performing 2 phases; an effort phase (stretch/crouch) and relaxed phase
  - Sequence is repeated 10 times per session, altering and randomizing the effort phase posture.
- Data is used to determine if changes occur:
  - Between Skylab posture and current posture(s)
  - Throughout duration of Mission or if posture stays the same

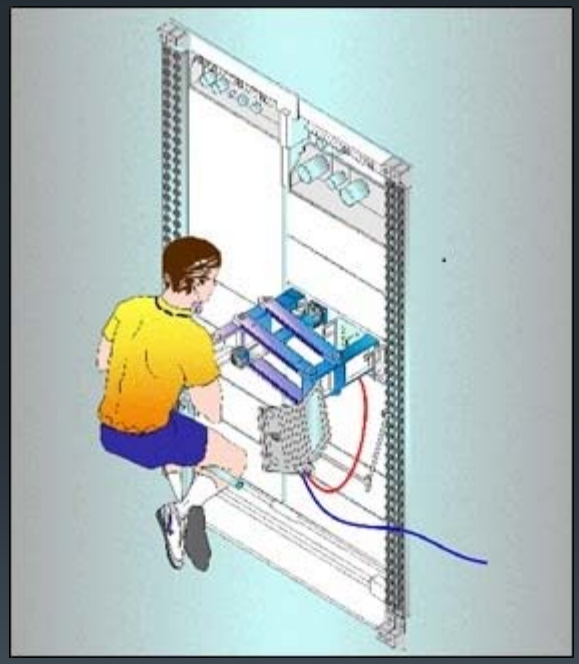
NBP Effort Phase: Crouch

NBP Effort Phase: Stretch

Study Description: Activity 3

Activity 3: Body Mass Measurement

- Collect weight pre- and post-flight
- Collect mass in-flight:
  - Space Linear Acceleration Mass Measuring Device (SLAMMD)
  - Russian Body Mass Measuring Device (BMMD)



SLAMMD Body Mass Measurement

Experiment Design Overview

Preflight	Inflight	Postflight
Body Measures Photographs 1x – L-180	Body Measures Photographs 3x (required) – FD 15, 80, R-30 3x (if time available) – FD 45, 105, 135	Body Measures Photographs 1x – R+30
Anthropometer 1x – L-180	NBP 3x 3x (required) – FD 15, 80, R-30 3x (if time available) – FD 45, 105, 135	Anthropometer 1x – R+30
Weight 1x – L-180	SLAMMD Body Measurements 3x – FD 15, 80, R-30	Weight 1x – R+30
3D Whole Body Laser Scanner 1X – L-180		3D Whole Body Laser Scanner 1x – R+30

Experiment Design Overview

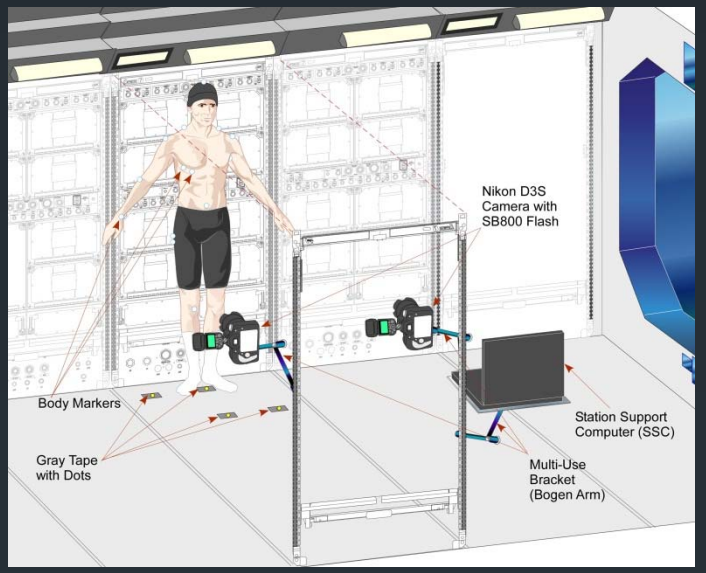
Measurements to be collected

Measurement	Pre-flight	In-flight	Post-flight
Stature	A, P, L	P	A, P, L
Acromion Height	A, P, L	P	A, P, L
Mid-Shoulder Height	A, P, L	P	A, P, L
Knee Height	A, P, L	P	A, P, L
Hip Height	A, P, L	P	A, P, L
Biacromion Breadth	A, P, L	P	A, P, L
Hip Breadth	A, P, L	P	A, P, L
Chest Breadth	A, P, L	P	A, P, L
Chest Depth	A, P, L	P	A, P, L
Waist Depth	A, P, L	P	A, P, L
Upper Arm Length	A, P, L	P	A, P, L
Lower Arm Length	A, P, L	P	A, P, L
Crotch Height	A, T, L	T	A, T, L
Chest Circumference	T, L	T	T, L
Waist Circumference	T, L	T	T, L
Hip Circumference	T, L	T	T, L
Bicep Circumference, flexed	T	T	T
Thigh Circumference	T	T	T
Calf Circumference	T, L	T	T, L
Weight/Mass	Scale	SLAMMD	Scale
NBP	-	V	-

A – Anthropometer
P - Photographs
T - Tape Measure
V – Video
L – Laser Scanner

Current Status

- This study is continuing inflight data collection
  - 5 subjects have completed the study
  - 8 subjects consented to participate (n=12)
  - Continue to analyze and process inflight data



Graphical representation of Activity #1

- Preliminary Results
  - Decrease in calf circumference
  - Height increase 1%-3% from preflight
    - Trend is showing a slight increase in height early in mission (FD15) and then plateau. This is similar to Skylab results.
  - Bicep Circumference, flexed stayed the same

Questions?