



Human Research Program Standard Measures in Analogs

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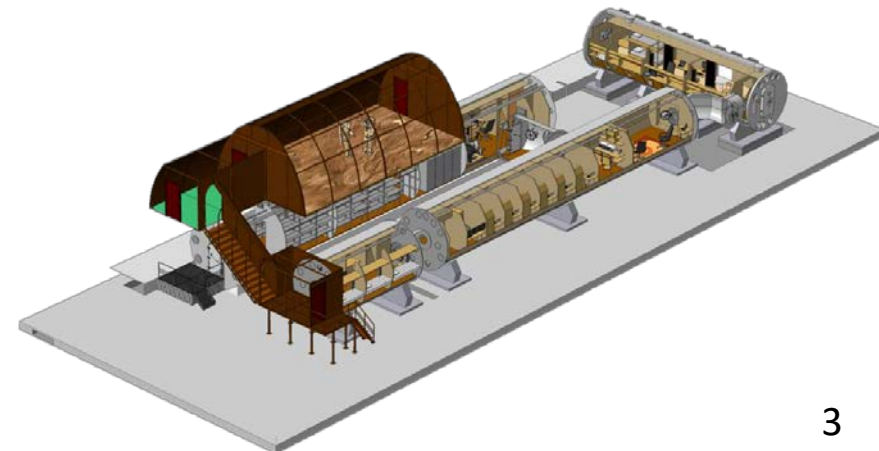
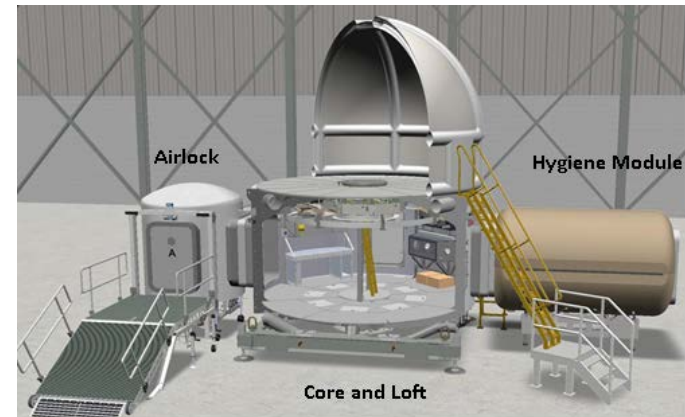


Objectives

- To ensure that a minimal set of measures, relevant to human spaceflight risks, is consistently captured from subjects participating in spaceflight analog environments
- The data from these measures will be placed in an archive managed by HRP and made available to studies via data sharing agreements
- *HRP Standard Measures* will constitute a database for:
 - Providing context for data acquired by concurrent experiments
 - Supporting or developing hypotheses
 - Evaluating the effectiveness of various countermeasure profiles
 - Comparing population responses to various mission durations and scenarios

Analogs

- **enviHab, DLR Cologne**
 - International Standard Measures
 - VaPER – 30 d
 - AGBRESA – 60 d
- **HERA, NASA JSC**
 - HRP Standard Measures
 - C5
 - C6
- **NEK, IBMP Moscow**
 - HRP Standard Measures
 - SIRIUS-19 – 120 d
 - SIRIUS-20 – 240 d

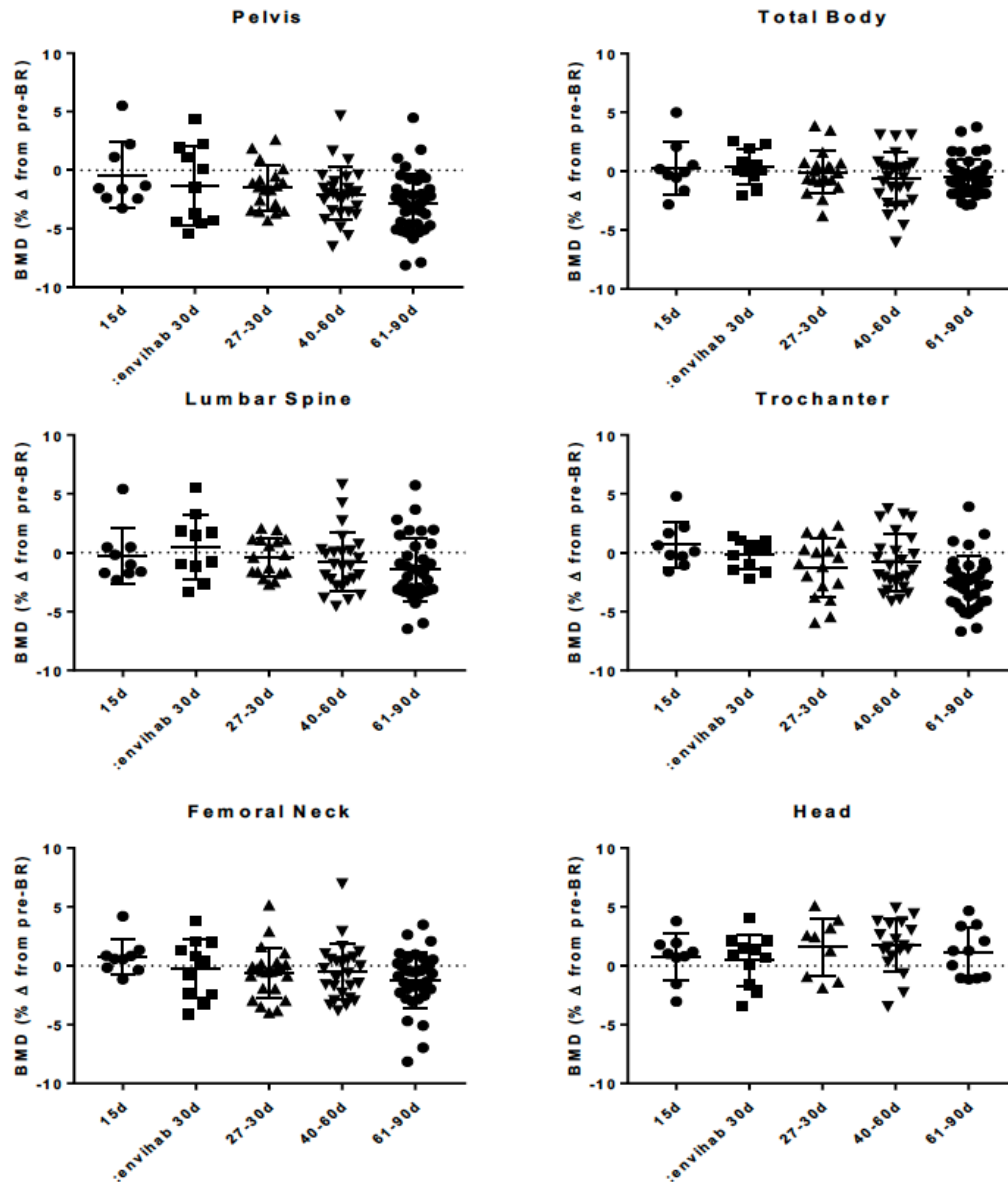




International Standard Measures Timeline

| Discipline | International Standard Measure | Pre | During | Post |
|----------------|--|-------|--------|--------|
| Psychology | Positive and Negative Affect Scale | BR-13 | BR14 | BR+1 |
| | General Health Questionnaire | BR-1 | BR28 | BR+13 |
| SANS | Ocular Tests (IOP, Ultrasound, OCT) | BR-3 | | BR+0 |
| Biochemistry | Nutritional assessment (blood, urine) Hematology | BR-3 | | BR+0 |
| Immunology | Immunology (blood, saliva) | BR-3 | | BR+0 |
| Muscle | Neuromuscular Power: Vertical Jump | BR-5 | | BR+0 |
| | Muscle Strength | BR-5 | | BR+2 |
| Bone | Bone Marker (blood) | BR-3 | | BR+0 |
| | Bone Mineral Density (DEXA) | BR-14 | | BR+11 |
| Cardiovascular | Orthostatic Tolerance Tilt Test | BR-5 | | BR+0 |
| | Maximal Aerobic Capacity (VO2 max) | BR-4 | | BR+0 |
| Sensorimotor | Postural Equilibrium Control | BR-1 | | BR+0 |
| | Treadmill Locomotion Test | BR-2 | | BR+0 |
| Vitals | Pulse, Blood pressure; Respiration rate; Weight; Height; Body temperature; Water intake; Urine output; Bowel movements Humidity; CO ₂ reading; Ambient temperature | Daily | Daily | Daily |
| Rehabilitation | Physiotherapy | | BR1-30 | BR+0-6 |
| | Reconditionning | | BR4-12 | |
| | Stretching | BR-4 | BR1-30 | |

VaPER Study – Bone Mineral Density



Mean (\pm SD) percent change in subjects' bone mineral density (BMD) in pelvis, whole body, lumbar spine, trochanter, femoral neck, and head (skull) after HDT bed rests ranging from 15 to 90 days.

The VaPER study is referred as “:envihab 30d”.

Data courtesy of Sara Zwart

VaPER Study – Sensorimotor Measures

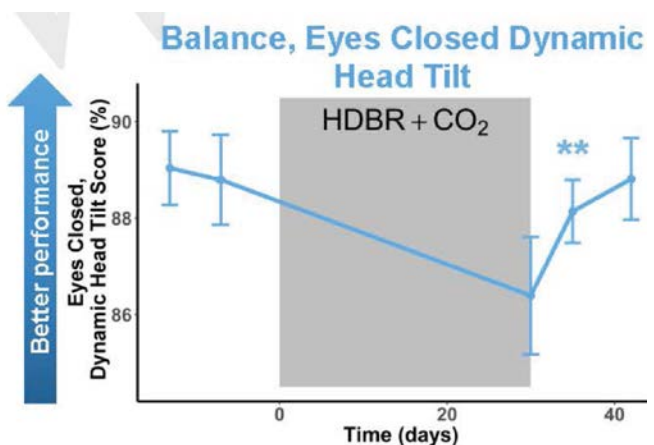
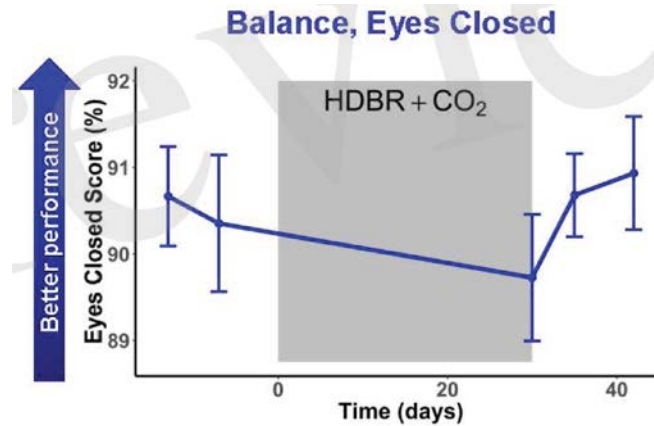
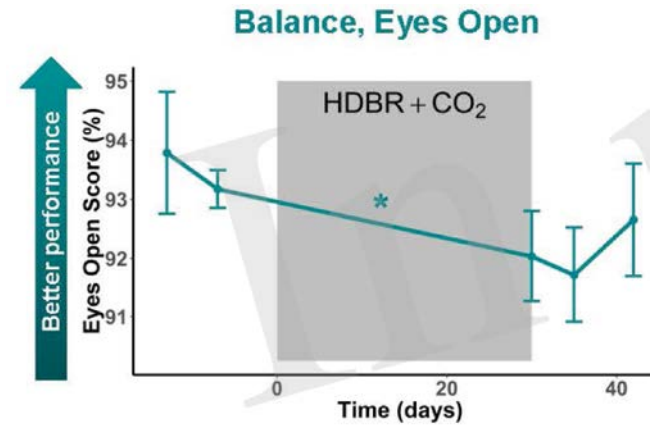
Hupfeld et al. (2020) Front Syst Neurosci, in press



Neural correlates of vestibular processing during a spaceflight analog with elevated carbon dioxide (CO₂): A pilot study

Kathleen E. Hupfeld¹, Jessica K. Lee², Nichole E. Gadd³, Igor S. Kofman³, Yiri E. De Dios³, Jacob Bloomberg⁴, Ajitkumar Mulavara³, Rachael D. Seidler^{1*}

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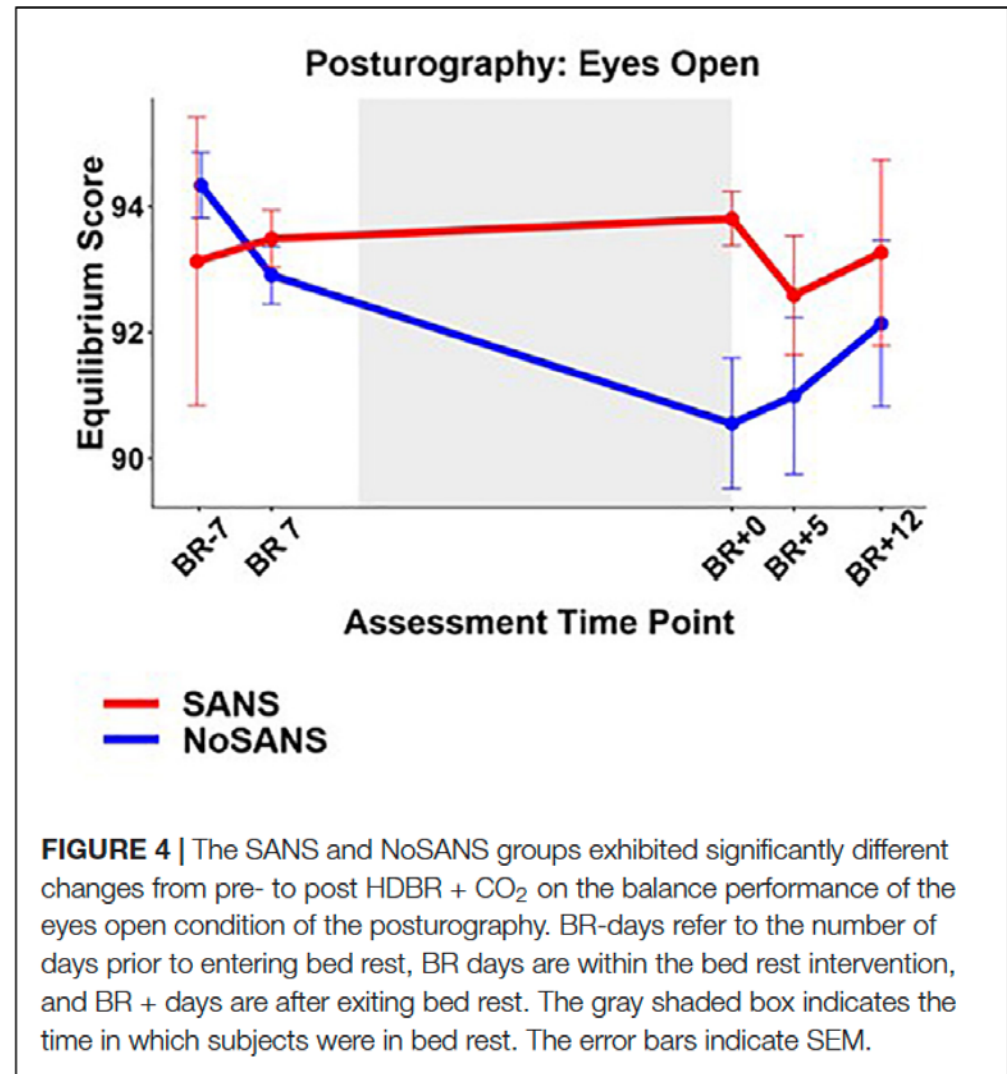
VaPER Study – Sensorimotor Measures

Lee et al. (2019) Front Hum Neurosc 13:355



Head Down Tilt Bed Rest Plus Elevated CO₂ as a Spaceflight Analog: Effects on Cognitive and Sensorimotor Performance

Jessica K. Lee^{1,2}, Yiri De Dios³, Igor Kofman³, Ajitkumar P. Mulavara³, Jacob J. Bloomberg⁴ and Rachael D. Seidler^{1,5*}





Differences Between SANS and no-SANS Groups

| Discipline | International Standard Measure | Significant Difference | In What Data |
|-------------------|---------------------------------------|-------------------------------|---|
| Psychology | Positive and Negative Affect Scale | Yes | <ul style="list-style-type: none">• Negative Affect• Anxiety• Insomnia |
| | General Health Questionnaire | Yes | |
| Biochemistry | Nutrition | No | |
| | Hematology | No | |
| Immunology | Immunology | No | |
| Muscle | Vertical Jump | No | |
| | Muscle Strength | No | |
| Bone | Bone Marker | No | |
| | Bone Mineral Density (DEXA) | No | |
| Cardiovascular | Orthostatic Tolerance Tilt Test | Yes | <ul style="list-style-type: none">• Pre-Post BR Percent change in Cardiac Output before tilt• Pre-Post Percent change in Brachial DBP during tilt• Heart Rate during bed rest |
| | Maximal Aerobic Capacity | Yes | |
| Sensorimotor | Postural Equilibrium Control | No | |
| | Treadmill Locomotion Test | No | |
| Vitals | Ancillary Measures | Yes | <ul style="list-style-type: none">• Respiration Rate• Body Temperature |



HERA HRP Standard Measures

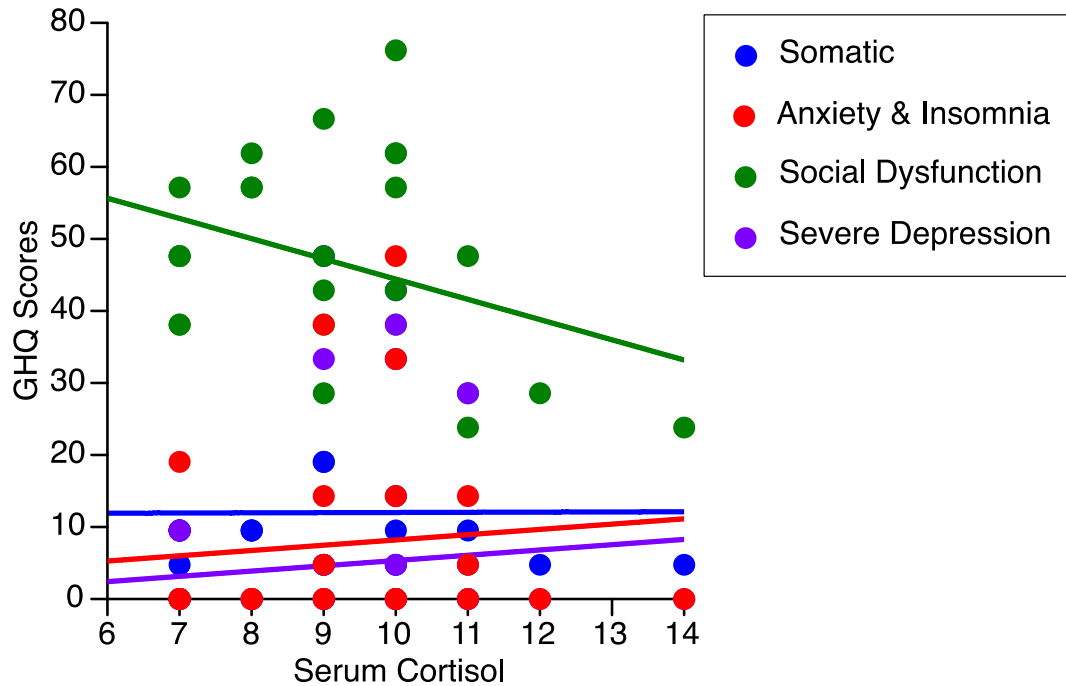
| Test Name | Methods | Pre | During | Post |
|--|---|------------------------------------|--|-------------------------------|
| Positive and Negative Affect Scale (PANAS) | The PANAS is a 20-item self-evaluation questionnaire that measures affects, or indicators of emotional states. The PANAS separately assesses positive and negative affects. A positive affect reflects the extent to which a person feels enthusiastic, active and alert. Low-positive affect is characterized by sadness and lethargy. A high-negative affect is described by anger, contempt, disgust, guilt, fear and nervousness. A low-negative affect describes a state of calmness and serenity. | BDC-13 ± 2d BDC-1 ± 1d 5 min | Weekly 5 min | R+1 ± 1d R+7 ± 2d 5 min |
| General Health Questionnaire (GHQ) | GHQ provides an overall total score for mental health. Each item on the GHQ is rated on a 4-point scale (0 to 3) indicating 'less than usual', 'no more than usual', 'rather more than usual', and 'much more than usual'. | BDC-13 ± 2d BDC-1 ± 1d 5 min | Weekly 5 min | R+1 ± 1d R+7 ± 2d 5 min |
| Serum Cortisol | Serum cortisol is assessed by liquid chromatography-tandem mass spectrometry (LC-MS/MS). The blood collection for this test (3.5 mL BD SST tube) is at the same time in the morning because there are known fluctuations throughout the day in healthy subjects. Total blood volume is 17.5 mL. | BDC-3 ± 2d 15 min | MD5 ± 2d MD20 ± 2d MD45 ± 2d 15 min | R+1 ± 1d 15 min |



NEK HRP Standard Measures

| Test Name | Methods | Pre | During | Post |
|--|---|------------------------------------|--|-------------------------------|
| Positive and Negative Affect Scale (PANAS) | The PANAS is a 20-item self-evaluation questionnaire that measures affects, or indicators of emotional states. The PANAS separately assesses positive and negative affects. A positive affect reflects the extent to which a person feels enthusiastic, active and alert. Low-positive affect is characterized by sadness and lethargy. A high-negative affect is described by anger, contempt, disgust, guilt, fear and nervousness. A low-negative affect describes a state of calmness and serenity. | BDC-13 ± 2d BDC-1 ± 1d 5 min | Weekly 5 min | R+1 ± 1d R+7 ± 2d 5 min |
| General Health Questionnaire (GHQ) | GHQ provides an overall total score for mental health. Each item on the GHQ is rated on a 4-point scale (0 to 3) indicating 'less than usual', 'no more than usual', 'rather more than usual', and 'much more than usual'. | BDC-13 ± 2d BDC-1 ± 1d 5 min | Weekly 5 min | R+1 ± 1d R+7 ± 2d 5 min |
| Serum Cortisol | Serum cortisol is assessed by liquid chromatography-tandem mass spectrometry (LC-MS/MS). The blood collection for this test (3.5 mL BD SST tube) is at the same time in the morning because there are known fluctuations throughout the day in healthy subjects. Total blood volume is 17.5 mL. | BDC-3 ± 2d 15 min | MD Early (2 wk) MD Mid (4 mo) MD Late (8 mo) 15 min | R+1 ± 1d 15 min |

SIRIUS-19 Preliminary Results



GHQ score, courtesy of Pete Roma
 Serum cortisol, courtesy of Sara Zwart