

SUPPLEMENTAL MATERIAL

Effects of Exercise Countermeasures on Multisystem Function in Long Duration Spaceflight Astronauts

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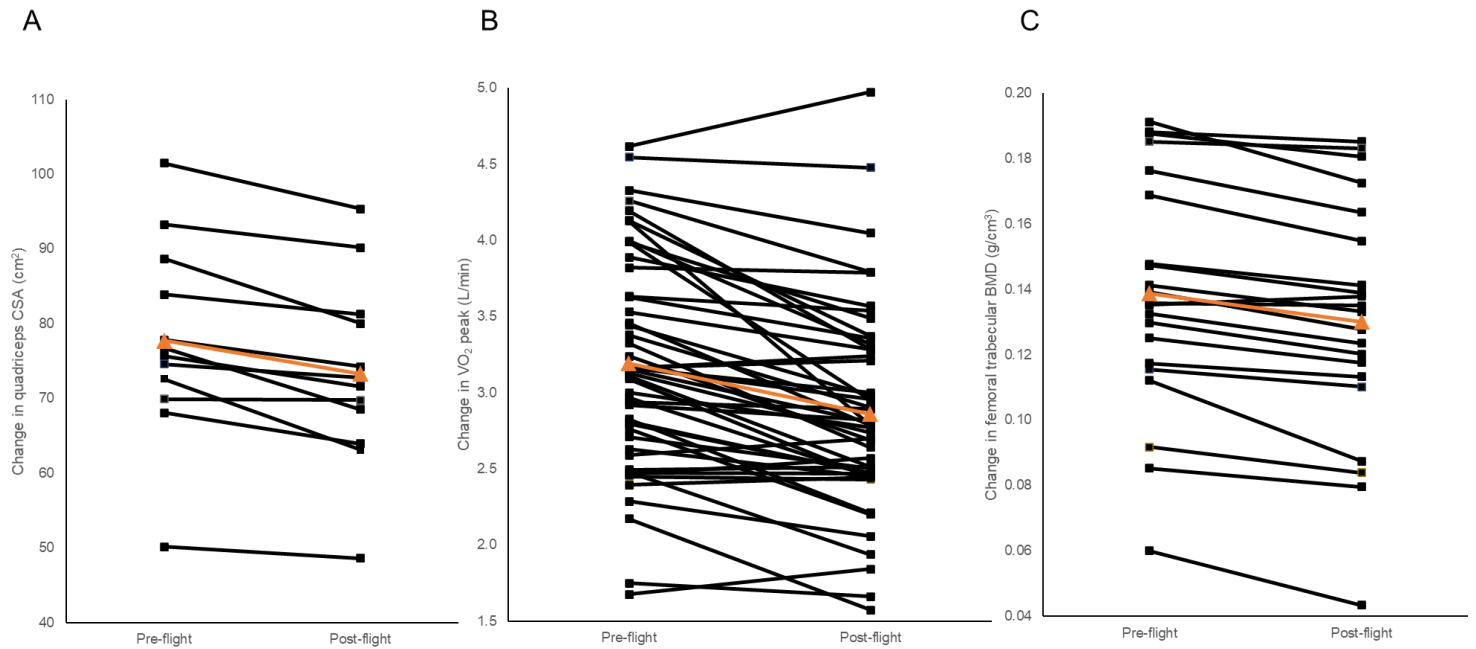
Supplemental Figure 1. The Second Generation Treadmill (T2) on ISS. NASA Image: ISS036-E-005384;
<https://www.nasa.gov/multimedia/guidelines/index.html>



Supplemental Figure 2. Cycle Ergometer with Vibration Isolation System (CEVIS) on ISS. NASA Image: SS039-E-014696; <https://www.nasa.gov/multimedia/guidelines/index.html>



Supplemental Figure 3. Advanced Resistive Exercise Device (ARED) on ISS. NASA Image: ISS038-E-000281; <https://www.nasa.gov/multimedia/guidelines/index.html>



Supplemental Figure 4. Inter-individual Heterogeneity in Response from Pre- to Post-flight. (A) Individual responses for quadriceps size. (B) Individual responses for VO₂peak. (C) Individual responses for bone content in trabecula femur. Abbreviations: CSA, cross sectional area; VO₂peak, peak oxygen consumption; BMD, bone mineral density.

Supplemental Table 1. In-flight Daily Caloric and Macronutrient Intake.

	Total	Relative to body weight, kg
Total calories (kcal)	2296 ± 449	29 ± 5
Protein (g)	112 ± 24	1.4 ± 0.3

Values are expressed as means ± SD.

Supplemental Table 2. Data Collection Schedule and Astronaut Participation.

System	N	Days before launch (preflight)	Days after Return (postflight)	Individual endpoints
Muscle strength, power, and size				
Isometric and ballistic leg press and bench press	17	30, 85	1, 7, 30	Leg press and bench press: force, power, total work
One-repetition maximum leg press and bench press	38	60, 90	1, 7	Leg press and bench press 1-RM
Cross sectional area (MRI)	12	40	1	Quadriceps, hamstring, calf
Cardiorespiratory fitness				
	21	28, 90	2, 7, 30	VO ₂ peak, ventilatory threshold, ventilation
Body composition (DXA)				
Muscle and fat mass	44	90	7	Total mass, fat mass, lean mass
Bone	44	90	7	Total hip, trochanter, femoral neck, L1-L4:
Bone volume (QCT)				
	12	90	7	Cortical and trabecular total femur, trochanter, femoral neck

Abbreviations: RM: repetition maximum; MRI, magnetic resonance imaging; DXA, Dual Energy X-ray Absorptiometry; QCT, quantitative computed tomography; L, lumbar.

Supplemental Table 3. Pre and Postflight Bone Mineral Density and Content.

	Preflight	N	Postflight	N
DXA				
Total hip (g/cm ²)	1.04±0.10	44	1.00±0.11	44
Trochanter (g/cm ²)	0.77±0.09	44	0.75±0.10	44
Femoral neck (g/cm ²)	0.86±0.10	44	0.84±0.10	44
L1-L4	1.09±0.13	44	1.06±0.13	44
QCT Trabecular				
Total Femur (g/cm ³)	0.143±0.03	12	0.137±0.03	12
Trochanteric (g/cm ³)	0.144±0.03	12	0.138±0.03	12
Femoral neck (g/cm ³)	0.133±0.04	12	0.122±0.04	12
QCT Cortical				
Total Femur (g/cm ³)	0.519±0.05	12	0.513±0.05	12
Trochanteric (g/cm ³)	0.524±0.05	12	0.516±0.05	12
Femoral neck (g/cm ³)	0.554±0.07	12	0.552±0.07	12

Values are means ± SD. Abbreviations: DXA, dual-energy x-ray absorptiometry; QCT, quantitative computed tomography

Supplemental Table 4. Pre and Postflight Muscle Strength and Size.

	Preflight	N	Postflight	N
Leg Press Force (N)	2027±500	15	1912±486	17
Leg Press Total Work (W)	8338±2198	14	7572±1985	17
Leg Press Max Power (W)	1829±405	14	1647±370	17
Leg Press 1-RM (lb)	639±154	38	614±144	39
Bench Press Force (N)	966±278	16	945±247	17
Bench Press Total Work (W)	3693±1147	16	3598±1169	17
Bench Press Max Power (W)	849±244	16	838±280	17
Bench Press 1-RM (lb)	181±46	38	186±49	37
Hamstring CSA (cm ²)	33.8±3.5	12	31.1±3.7	12
Quad CSA (cm ²)	77.7±13.2	12	73.3±12.5	12
Calf CSA (cm ²)	17.7±4.1	12	15.6	12

Values are mean ± SD. Abbreviations: RM, repetition maximum; CSA, cross sectional area.

Supplemental Table 5. Pre and Postflight Cardiorespiratory Fitness.

	Preflight	N	Postflight	N
VO ₂ peak (L/min)	3.16±0.05	26	2.93±0.06	21
Ventilation (ml)	135.8±2.8	26	130.0±3.5	21
Ventilatory Threshold (L/min)	2.84±0.07	22	2.88±0.06	13

Values are mean ± SD. Abbreviations: VO₂peak; peak oxygen consumption

Supplemental Table 6. Pre and Postflight Body Composition.

	Preflight	N	Postflight	N
Total Mass (kg)	78.3±9.8	44	78.0±10.2	44
Fat (kg)	19.2±4.6	44	18.7±4.9	44
Lean (kg)	56.2±7.8	44	56.5±8.3	44

Values are means ± SD.