

LEG BLOOD FLOW RESTRICTION DURING ROWING EXERCISE AS A COUNTERMEASURE FOR MICROGRAVITY INDUCED DECONDITIONING

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THE PROBLEM

MICROGRAVITY EXPOSURE: LONG-TERM SPACEFLIGHT LEADS TO DECONDITIONING.

- ORTHOSTATIC INTOLERANCE UPON RE-ENTRY
- 20% OF MUSCLE MASS IS LOST DURING FIRST FOUR MONTHS IN SPACE (MOORE ET AL., 1985)
- MAXIMAL OXYGEN UPTAKE ($\dot{V}O_{2\text{PEAK}}$) DECREASES $\sim 17\%$ (PERHONEN ET AL., 2001)

EMERGENCY EGRESS TASKS MAY REQUIRE WORK INTENSITIES AT 85% OF MAX HEART RATE. EVEN A SMALL DECREASE IN $\dot{V}O_{2\text{PEAK}}$ (E.G. 10%) CAN GREATLY IMPACT ABILITY TO COMPLETE THESE TASKS (BISHOP ET AL., 1999).

CURRENT COUNTERMEASURES

ADVANCED RESISTANCE
EXERCISE DEVICE.



https://www.nasa.gov/mission_pages/station/research/experiments/1001.html

Cycle Ergometer with
Vibration Isolation and
Stabilization System.



https://www.nasa.gov/mission_pages/station/multimedia/exp20_work.html

COMBINED OPERATIONAL
LOAD BEARING EXTERNAL
TREADMILL.



https://www.nasa.gov/mission_pages/station/multimedia/gallery/iss032e011701.html

CURRENT COUNTERMEASURES

- PREVIOUS MISSIONS USED PRESSURIZED CUFFS TO PROMOTE BLOOD FLOW TO LEGS (HAWKEY, 2003).
 - LOWER BODY NEGATIVE PRESSURE (LBNP) DEVICES.
- DEVICES ARE LARGE AND RESTRICTED ASTRONAUT MOVEMENT.

WHAT CAN BE DONE?



BLOOD FLOW RESTRICTION & ROWING EXERCISE

- EXERCISE INTERVENTION ORIGINATING IN JAPAN.
 - CLINICAL, ELITE-ATHLETE, ELDERLY.
 - RUMORED TO BE ON THE ISS.
- FLYWHEEL DEVICES, CONCURRENT TRAINING.



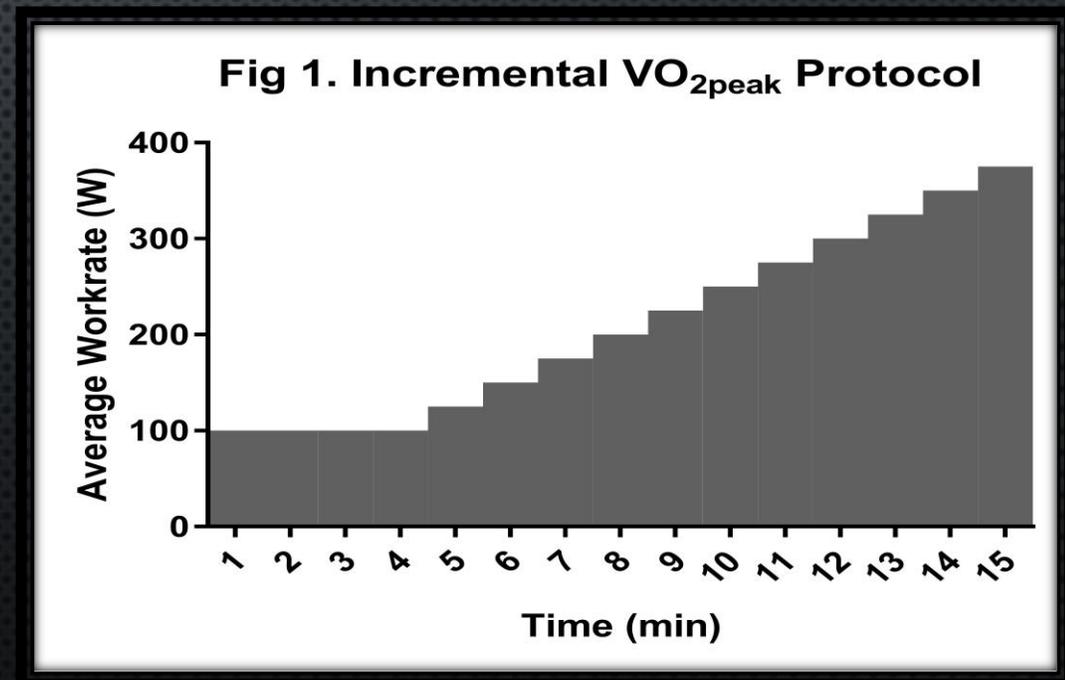
<http://www.concept2.com/indoor-rowers/model-e>



<https://www.kaatsu-global.com/kaatsu-main-page/>

THE FIVE W'S

- WHO: 20 HEALTHY, TRAINED PARTICIPANTS (22.1 ± 1.71 YEARS)
- WHAT: LEG BLOOD FLOW RESTRICTION DURING ROWING EXERCISE
 - HEART RATE, BLOOD PRESSURE, WHOLE BLOOD LACTATE, MUSCLE ACTIVITY, RATE OF PERCEIVED EXERTION
- WHEN: TWO EXERCISE SESSIONS: $\text{VO}_{2\text{PEAK}}$ & CON/BFR
- WHERE: HUMAN PERFORMANCE LAB – NDSU
- WHY: TO ESTABLISH ACUTE PHYSIOLOGICAL RESPONSES





VO₂ PEAK TESTING

RESULTS

- INCREASED CARDIOVASCULAR RESPONSES.
 - HR (120.5 ± 5.53 vs. 128.9 ± 9.86)
 - NO CHANGE IN BLOOD PRESSURE
- INCREASE IN PERCEIVED EXERTION.
 - RPE (9.8 ± 1.85 vs. 11.8 ± 1.88)
- NO CHANGE IN RESISTANCE EXERCISE RESPONSES.
 - LACTATE, MUSCLE ACTIVITY

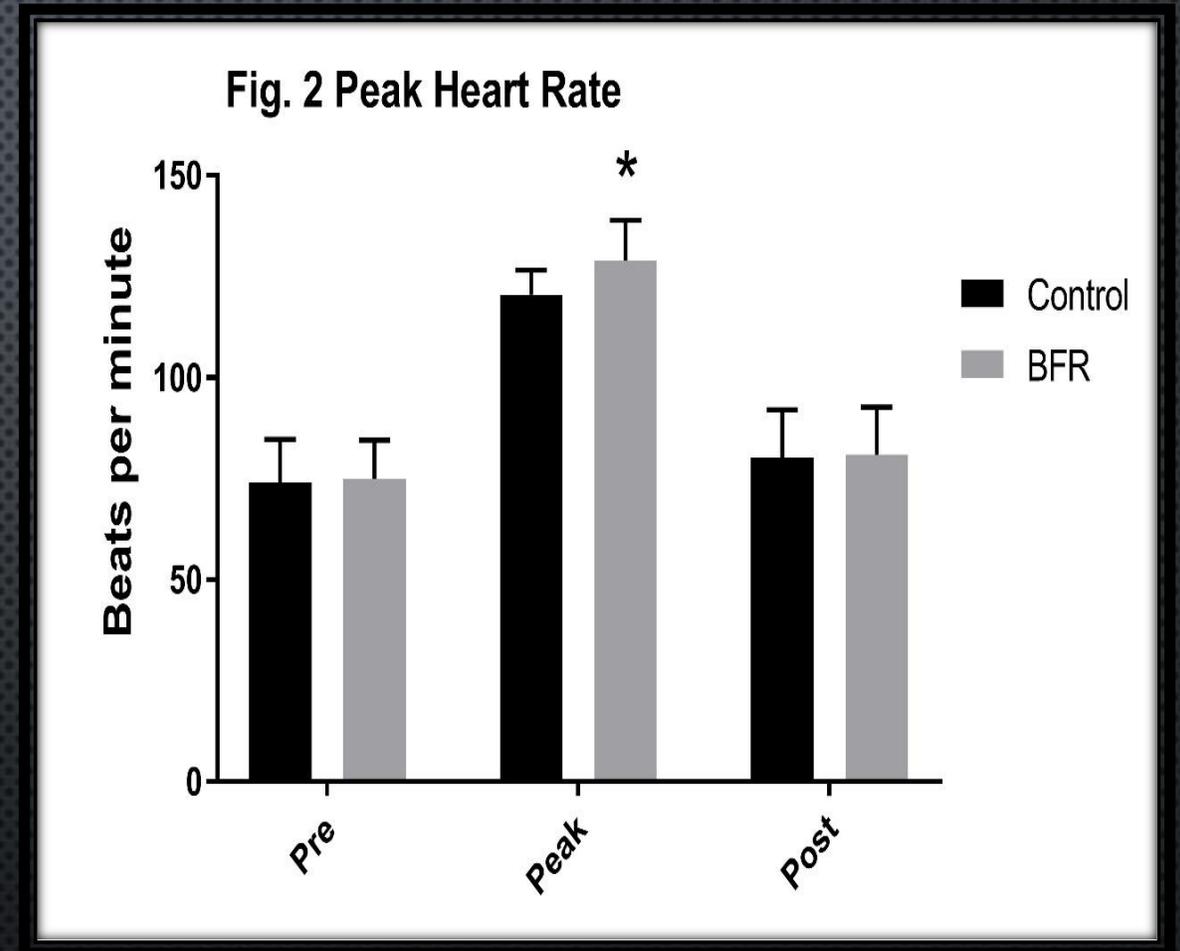


Figure Note: Peak HR taken pre-, during, and post-exercise. * denotes significance at $p < 0.05$

DISCUSSION

- HEART RATE RESPONSE WAS LOWER DURING ROWING BFR THAN PREVIOUSLY REPORTED (RENZI ET AL., 2010).
 - (~7% vs. ~20%)
- PREVIOUS RESEARCH HAS SHOWN THAT INCREASED MUSCLE ACTIVITY IS ASSOCIATED WITH INCREASED LACTATE ACCUMULATION DURING HYPOXIA (TAKARADA ET AL., 2000).
 - POSSIBLE EXERCISE INTENSITY AND CUFF PRESSURE WERE NOT HIGH ENOUGH
 - LACTATE CAN ALSO BE USED AS A FUEL SOURCE (BROOKS, 1998).
- RESPONSES FROM BFR EXERCISE ARE STILL LOWER THAN TRADITIONAL HIGH-INTENSITY EXERCISE (LOENNEKE ET AL. 2011).

CONCLUSION

- EXERCISE INTENSITY (30%) AND/OR CUFF INFLATION PRESSURE (150-160 MMHG) WERE NOT SUFFICIENT TO SIMULTANEOUSLY ELICIT CARDIOVASCULAR AND RESISTANCE TRAINING RESPONSES.
- FUTURE RESEARCH SHOULD ESTABLISH NORMS.
- LEG BFR DURING ROWING COULD PROVE TO BE A SUPPLEMENTAL COUNTERMEASURE DURING LONG DURATION SPACEFLIGHT.

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