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# LBNP EXERCISE AND FLYWHEEL RESISTIVE EXERCISE AS AN EFFECTIVE COUNTERMEASURE COMBINATION

[1, 2]Meuche, S; [3]Schneider, SM; [4]Lee, SMC; [1]Macias, BR; [5]Smith, SM; [6]Watenpaugh, DE; [1]Hargens, AR
[1]University of California, San Diego-Department of Orthopaedic Surgery; [2]Charité-Universitaetsmedizin Berlin - Center for Space Medicine Berlin (ZWMB), Germany; [3]University of New Mexico, Albuquerque, NM; [4]Wyle Life Sciences, Houston, TX; [5]NASA Johnson Space Center, Houston, TX; [6]Sleep Consultant, Inc, Fort Worth, TX
sabinemeuche@gmx.de

**Introduction:** Long-term exposure to microgravity can cause a severe musculoskeletal loss and cardiovascular deconditioning in astronauts. In this report, the effectiveness of combined supine treadmill exercise in a lower body negative pressure chamber (LBNPex) and flywheel resistive exercise (Rex) countermeasures was determined to prevent bone loss, reduced aerobic upright exercise capacity and reduced muscle strength. We hypothesized that exercise subjects (EX) would show less decrease in bone mineral density (BMD), peak oxygen consumption ($VO_2$pk) and knee extensor strength (KES) than control subjects (CON).
**Methods:** Sixteen healthy female subjects (34±4yrs, 164±6.5cm, 58±5kg; mean±SD) participated in a 60-d 6° head-down tilt bed rest (BR) study after providing written informed consent. Subjects were assigned to one of two groups: a non- exercising CON group or an EX group performing LBNPex 2-4 d/wk and Rex every 3$^{rd}$-d. $VO_2$pk was measured with a maximal, graded, upright treadmill test performed pre-BR and on 3-d after BR. BMD was assessed pre-BR and 3-d after BR by dual energy x-ray absorptiometry total body DEXA scan (DEXA; HOLOGIC QDR 4500 Elite®). A Cybex® dynamometer was employed to measure the isokinetic KES before and 5-d after BR. Two-way repeated measures ANOVA were performed with time as the repeated factor. Statistical significance was set at $p<0.05$.
**Results:** CON experienced a significant decrease in BMD in the trochanter (PRE: 0.670±0.045; POST: 0.646±0.352 g·cm$^{-2}$) and in the whole hip (PRE: 0.894±0.059; POST: 0.858±0.057 g·cm$^{-2}$). BMD also decreased significantly in EX in the trochanter (PRE: 0.753±0.0617; POST: 0.741±0.061 g·cm$^{-2}$) and whole hip (PRE: 0.954±0.067; POST: 0.935±0.069 g·cm$^{-2}$). BMD losses were significantly less in EX than in CON subjects. $VO_2$pk was significantly decreased in the CON after BR (PRE: 38.0±4.8; POST: 29.9±4.2 ml·kg$^{-1}$·min$^{-1}$), but not in the EX (PRE: 39.0±2.0; POST: 37.8±1.9 ml·kg$^{-1}$·min$^{-1}$). KES was significantly reduced by 30% in CON (PRE: 113±12; POST: 78±8 N-m), but was not different in EX (PRE: 126±25; POST: 115±25 N-m).
**Conclusion:** The combination LBNPex and Rex during 60-d BR protects against cardiovascular and musculoskeletal deconditioning and may be an efficacious countermeasure for prolonged space flight.

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