Treadmill Running and Tower Climbing Resistance Exercise Mitigate Disuse Bone Loss in Mice Equally Well

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ABSTRACT

INTRODUCTION: Astronauts on long-duration missions continue to experience bone loss, as much as 1 – 2% each month, after a mission. Mechanical stimulation through exercise has been shown to increase bone formation. Therefore, the hypothesis of this study was that resistance training would better mitigate deleterious musculoskeletal effects of reduced gravitational weight bearing (1/6th body weight) when compared to endurance exercise. MATERIALS & METHODS: Four-month-old female BALB/cBYJ mice were randomly assigned to three groups: 1/6g (G/6; n=6), 1/6g with treadmill running (G/6+RUN; n=8), or 1/6g with vertical tower climbing (G/6+CLB; n=9). Exercise was performed 5 times per week. Reduced weight bearing was achieved through a novel harness system. Treadmill velocity (12 – 20 m/min) and daily run time duration (32 – 51 min) increased incrementally throughout the study. G/6+CLB mice climbed a 1-meter vertical wire-mesh tower. Number of climbs (50 –36 climbs) decreased as added weights (0 – 175% BW) increased in order to maintain constant total work. Bone geometry and volumetric bone mineral density (vBMD) were assessed by peripheral quantitative computed tomography (pQCT) on days 0 and 21 and standard histomorphometry was performed on undemineralized sections of midshaft tibia after tissue harvest. RESULTS: Compared to baseline controls, G/6 caused a significant decrease ($P<0.001$) in proximal tibia total vBMD (-9.6%). This reduced proximal tibia vBMD in G/6 mice was mitigated by both G/6+RUN and G/6+CLB ($P<0.05$). After 21 days of G/6, we saw an absolute increase in tibia midshaft vBMD and in distal femur vBMD in both G/6+RUN and G/6+CLB mice ($P<0.05$). Small increases in endocortical and periosteal % mineralizing surface at midshaft tibia suggest that bone formation was increased by both G/6+RUN and G/6+CLB when compared to G/6. CONCLUSION: These data suggest that moderately vigorous endurance exercise and resistance training, as simulated by our climb training protocol, can mitigate decrements in vBMD during 21 days of reduced weight bearing. Contrary to our hypothesis, both exercise regimens worked equally well at achieving this goal.