Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.37246

Effect of resistance vibration exercise with and without artificial gravity during 60-d 6°head down tilt bed rest on bone mineral density (BRAVE study) - Assessed by Calcium Isotopes

RAPHAEL BOCHET[1], URŠA CIUHA[1], IGOR MEKJAVIČ[1], MATEJ DROBNIČ[2] AND **TEA ZULIANI**[1,3]

[1]Jožef Stefan Institute
[2]University of Ljubljana, Faculty of medicine
[3]Jozef Stefan International Postgraduate School

Following prolonged exposure to microgravity during missions on the International Space Station, astronauts experience significant bone loss, particularly in weight-bearing limbs. Adaptation of physiological systems to microgravity is commonly investigated using head-down tilt bed rest studies in healthy volunteers, which also provide a controlled model to test countermeasures such as exercise.

Natural stable calcium (Ca) isotopes have recently emerged as sensitive tracers of bone mineral balance, based on the observation that bone is isotopically lighter than soft tissues. During net bone loss, preferential release of isotopically light Ca from the skeleton is expected to shift circulating Ca isotope compositions toward lower $\delta^{44/42}$Ca values. This isotopic approach could offer a dynamic, earlier indicator of skeletal changes compared to conventional imaging methods and is potentially suited to controlled bed rest interventions.

Within the framework of the European Space Agency BRAVE (Bed Rest Artificial Gravity and Vibration Exercise) study, we investigated the efficacy of resistance vibration exercise performed with and without artificial gravity in mitigating alterations in bone mineral balance. Healthy males (N = 24) underwent 60 days of 6° head-down tilt bed rest and were assigned to one of three groups: (i) Control (no exercise), (ii) Resistance vibration exercise (RVE) performed in the horizontal position using a squat device with superimposed vibration, and (iii) Resistance vibration exercise with artificial gravity (AGRVE) generated by a short-arm human centrifuge in the head-to-foot direction. Exercise was performed six days per week, with one rest day. Blood samples were collected before bed rest, at regular intervals during the intervention, and immediately afterward.

By measuring Ca isotope ratios in serum, we tested the hypothesis that participants subjected to prolonged bed rest without exercise would exhibit a greater change of $\delta^{44/42}$Ca values than those who remained active, despite both groups maintaining a horizontal position. In addition, we compared the effect of exercise with and without artificial gravity on bone mineral balance. Isotope results were evaluated alongside established biochemical markers of bone mineral balance.