

# Effects of resistive vibration exercise combined with whey protein and $\text{KHCO}_3$ on bone turnover markers in head-down tilt bed rest (MTBR-MNX Study)

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High protein intake further increases bone resorption markers in head-down tilt bed rest (HDBR), most likely induced by low-grade metabolic acidosis. Adding an alkaline salt to a diet with high protein content prevents this additional rise of bone resorption markers in HDBR. In addition, high protein intake, specifically whey protein, increases muscle protein synthesis and improves glucose tolerance, which both are affected by HDBR. Resistive vibration exercise (RVE) training counteracts the inactivity-induced bone resorption during HDBR. To test the hypothesis that WP plus alkaline salt ( $\text{KHCO}_3$ ) together with RVE during HDBR will improve bone turnover markers, we conducted a randomized, three-campaign crossover design study with 12 healthy, moderately fit male subjects (age  $34 \pm 8$  y, body mass [BM]  $70 \pm 8$  kg). All study campaigns consisted of a 7-d ambulatory period, 21 days of  $-6^\circ$  head-down tilt bed rest (HDBR), and a 6-d recovery period. Diet was standardized and identical across phases. In the control (CON) campaign, subjects received no supplement or RVE. In the intervention campaigns, subjects received either RVE alone or combined with WP and  $\text{KHCO}_3$  (NEX). WP was applied in 3 doses per day of 0.6 g WP/kg BM together with 6 doses of 15 mmol  $\text{KHCO}_3$  per day. Eleven subjects completed the RVE and CON campaign, 8 subjects completed all three campaigns. On day 21 of HDBR excretion of the bone resorption marker C-telopeptide (CTX) was  $80 \pm 28\%$  ( $p < 0.001$ ) higher than baseline, serum calcium concentrations increased by  $12 \pm 29\%$  ( $p < 0.001$ ) and serum osteocalcin concentrations decreased by  $6 \pm 12\%$  ( $p = 0.001$ ). Urinary CTX excretion was  $11 \pm 25\%$  ( $p = 0.02$ ) lower on day 21 of HDBR in the RVE- and tended to decrease by  $3 \pm 22\%$  ( $p = 0.06$ ) in the NEX campaign compared to CON. Urinary calcium excretion was higher on day 21 in HDBR in the RVE and NEX ( $24 \pm 43\%$   $p = 0.01$ ;  $25 \pm 37\%$   $p = 0.03$ ) compared to the CON campaign. We conclude that combination of RVE with WP/ $\text{KHCO}_3$  was not superior to RVE alone in any of these results.

Funded by the DLR Space Program with allocation of funds from the federal ministry of economy and technology under the support code: 50WB1231.