Bone Density Following Three Years of Recovery from Long-Duration Space Flight

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SUMMARY OF RESULTS

In summary, BMD measurements following long-duration space flight showed a decrease in bone density compared to pre-flight levels, with a noticeable recovery trend observed in the first year. Results indicate that while BMD partially recovers, it does not return to pre-flight levels, and there are persisting deficits in bone density beyond the initial post-flight period.

CONCLUSIONS

- By ~3 yrs after landing, BMD at most sites in male US crew became closer to what would be predicted, derived from a community-based cohort of men.
- However, hip BMD, the site most affected by exposure to microgravity, remained lower than what would be predicted, even after ~3 yrs following return from space.
- Findings suggest a potential long-term negative impact of long-duration space flight on load-bearing bones of men.
- ImPLICATIONS of these findings on future hip fracture risk for men serving on long-duration missions in space remain unknown.

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BACKGROUND

It is well recognized that bone mineral density (BMD) at load-bearing sites of the hip and spine sustain significant loss during space flight, estimated at ~0.5-1.0% per month. (LeBlanc J Musc Neur Int 2007)

However, the long-term effects on bone health following return from long-duration space flight remain unclear.

METHODS

Prediction Models for BMD
- Prediction models were created using 348 men [mean age ± SD: 55 ± 20 yrs, range: 22-90 yrs] who represented an age-stratified random sample of the Rochester, MN community, and who had longitudinal BMD measurements over 4 yrs of follow-up.

RESULTS

BMD Measurements in Community-Based Cohort
- BMD was measured in the community-based cohort of men at baseline, 2 yrs and 4 yrs of follow-up using the QDR 2000 scanner and at the same sites listed for US crew members.

Analyses
- We created prediction models for follow-up BMD using the community cohort of men.
- We used linear mixed-effects models to predict follow-up BMD using baseline BMD, age and follow-up time, adjusting for the fact that most people were measured more than once.
- We then applied the created models to predict follow-up BMD for US crew members and compared them to what was actually observed immediately and at ~36 months post-flight

LIMITATIONS

- BMD is a surrogate measure of bone strength; differences in predicted and observed BMD may still underestimate deficits in bone strength, given recent findings based on finite-element models of QCT hip scans from US crew (Lang JBMR 2004 & 2006; Keyak Bone 2009).
- There were too few women with BMD measures ~3 yrs after landing to be able to confirm that there remained no long-term negative effects on bone.
- Analyses are limited to those men who returned for BMD measures.

METHODS

Study Subjects
- Male US crew members serving on long-duration missions in space aboard Mir or ISS who had BMD measurements beyond ~12 months since their return.
- Of 36 US crew who have served on Mir or ISS, and have had pre- and at least one post-flight BMD measured as of December 2010, 28 are men.
- 15/28 men [mean age ± SD at pre-flight BMD: 47 ± 5 yrs, range: 36-54 yrs] have had their BMD measured up to ~3 yrs after landing.

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