MAYO CLINIC

DES SHORT-DURATION SPACE FLIGHT HAVE A NEGATIVE EFFECT ON BONE DENSITY?

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BACKGROUND

- Unlike the effect on bone loss of long-duration microgravity exposure, the effect on bone of short-duration exposure to microgravity has not been as well studied.
- Bone resorption markers increase within days of microgravity exposure, with an uncoupling from bone formation markers observed.
- The mechanism for bone loss in the microgravity environment of space is likely multifactorial, with some having a short-term effect, while others potentially contributing to long-term consequences.
- Although short-term exposure to microgravity may not have a measurable effect on bone density immediately after flight, it is unknown what effect cumulative exposure to short-duration space flight has on bone density long-term.

OBJECTIVES

- To examine the effect of cumulative short-duration space exposure on bone density among US crew members.

METHODS

Study Subjects

- All US crew members serving on a short-duration space flight mission (defined as <30 consecutive days in space) before any long-duration space flight, who have had their bone mineral density (BMD) measured at least once and who provided written informed consent to analyze their data.
- For any crew members who served on both a short- and long-duration space mission, we excluded from analyses any BMDs measured after the long-duration space flight.

METHODS

BMD Measurements in US Crew members

- BMD (g/cm^2) by DXA was measured between 1991-2010, and triennially as of 1997, but with no specific timing around short-duration flights.
- BMD was measured using 4 different scanners (Hologic QDR 1000, 2000, 4500 & Discovery) over time.
- BMD measures at the total hip, lumbar spine, wrist (ultra-distal and mid-shaft radius) and total body, prior to any long-duration flight, were used in analyses.

Cumulative Space Flight Exposure

- Cumulative exposure to space was defined in 2 ways:

  1) total number of days in space prior to a BMD measurement

  2) total number of days in space within 2 years prior to a BMD measurement

Covariates in Analyses

- Age at the time of BMD measurement
- DXA Scanner

Analyses

- To examine the effect of cumulative space flight exposure on BMD, we used linear mixed effects models, accounting for the fact that each crew member may have had multiple BMD measures.
- We examined the effect of either definition of cumulative space flight exposure on each BMD site available.
- All analyses were adjusted for age at BMD and DXA scanner.
- Men and women were analyzed separately.

RESULTS

- Among 259 eligible US crew members (217 men and 42 women), 21% either declined participation, were not able to be contacted or did not respond, leaving 175 men and 30 women for analyses.
- The median days per short duration flight was 10 days (range <1-28) for men and 10 days (range 4-17) for women. Additional descriptive characteristics are summarized in the Table.

Descriptive Characteristics for Men and Women Median (range)

	Men N=175	Women N=30
# of Short-Duration Flights	2 (1-7)	3 (1-5)
Cumulative Days in Space (days)	23 (5-67)	29 (8-56)
# of BMD Scans	3 (1-14)	5 (1-6)
Age at 1st BMD Scan (yrs)	44 (31-81)	39 (29-53)

- In men, the BMD at all sites tended to be slightly lower with greater total cumulative days in space, but was only statistically significant at the spine:
  - *for every 10 cumulative days in space, the lumbar spine BMD was 0.016 g/cm^2 lower, $p<0.0001$*
- Restricting the cumulative duration in space exposure to within 2 yrs prior to the BMD measure, most sites in men showed no association with cumulative duration in space except at the mid-shaft radius, but the effect was small: *for every 10 cumulative days in space within 2 yrs of BMD measurement, the mid-shaft radius was 0.003 g/cm^2 lower, $p=0.016$*
- Interestingly, women showed a similar association as men: *for every 10 cumulative days in space within 2 yrs prior to BMD, the mid-shaft radius was 0.006 g/cm^2 lower, but was not statistically significant ($p=0.094$)*
- Other than the observation at the mid-shaft radius, greater cumulative space exposure (total or within 2 yrs prior to BMD) was not significantly associated with lower BMD at any site in women.

SUMMARY

- For every 10 days of cumulative space flight exposure, the lumbar spine BMD was 0.016 g/cm^2 lower in men ($p<0.0001$)
- For every 10 days of cumulative space flight exposure within 2 yrs prior to BMD measure, the mid-shaft radius BMD was 0.003 g/cm^2 lower in men ($p=0.016$) and 0.006 g/cm^2 lower in women ($p=0.094$), but these effects are small.
- We found no other significant negative effect of cumulative space exposure on BMD in either women or men.

LIMITATIONS

- The N of women was small so our power to detect an effect may have been limited.
- Although our participation rate by US crew members was favorable, it is unknown if results would be similar if data from non-participants were available for analyses.

CONCLUSIONS

- We found no negative effect of cumulative short-duration space flight, at most sites, in men or women.
- While our observations of lower BMD at the mid-shaft radius were consistent between men and women, they were still overall small.
- Our findings of lower lumbar spine BMD in men with longer cumulative space flight exposure is intriguing and deserves further exploration.

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