**Bone Mineral Density Maintenance During Long-Duration Spaceflight**

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Prolonged microgravity exposure disrupts natural bone remodeling processes and can lead to a significant loss of bone strength, increasing injury risk during missions and placing astronauts at a greater risk of bone fracture later in life. Resistance-based exercise during missions can combat bone loss, but the amount of required exercise to maintain bone mineral density (BMD) for individuals is unclear. We present work to develop a personalizable, site-specific computational modeling toolchain of bone remodeling dynamics to understand and estimate changes in volumetric BMD in response to microgravity-induced bone unloading and in-flight exercise. The toolchain is evaluated against data collected from subjects in a 70-day bed rest study, and is found to provide insight into the amount of exercise stimulus needed to minimize bone loss, quantitatively predicting post-study volumetric BMD of control subjects who did not perform exercise, and qualitatively predicting the effects of exercise. Results suggest that, with additional data, the toolchain could be further developed to aid in the creation of customized in-flight exercise regimens and to predict exercise effectiveness.