Contribution ID: **229** Type: **Poster**

Alteration of the brain-to-bone axis in microgravity as a factor for bone loss for long-term spaceflight and a potential focus for prospective countermeasures

Space exploration in the next 30 to 50 years will proceed as follows: first return to the Moon and settle there permanently, and once successful, establish a human colony on Mars. To ensure successful human exploration beyond low Earth orbit, it is critical to investigate the effects of space environments on physiology, crew performance and overall health. While anti-resorptive drugs, a proper diet and vitamins and minerals supplementation are used to address the issue today, this is not sufficient for more than 6-month in microgravity as it is paramount for the first astronauts landing on Mars to be able to explore the red planet's surface when arriving. Even with these countermeasures and intensive postflight reconditioning, full recovery is long and leaves scars even though some studies have shown that it remains incomplete. Until recreating Earth's gravity in space becomes a reality, it is critical to understand how microgravity combined with other stressors, will impact human physiology. Additionally, mitigating bone loss in space would also significantly prevent kidney stone development as a result. Evidence shows that the main cause of muscle and bone loss is physical unloading and the subsequent lack of muscular activity. As stated by NASA's knowledge gap (M23), finding more effective countermeasures requires a thorough understanding of all factors in the space environment affecting bone and muscle loss. Muscle atrophy and strength loss may result from neurophysiological deterioration in both bone and muscle and the ability of electrical signals to propagate properly across synapses may be affected by microgravity. It has already been shown that microgravity negatively affects motor neuron functions. This research aims to better understand brain and bones interaction, especially in space. To this end, rodents will be placed in a Random Positioning Machine (RPM) 20-22 hours a day for four weeks, to determine possible denervation and a possible imbalance of targeted neuropeptides. While the experiment and subsequent analysis for this project are still ongoing, the results of this study will provide original empirical evidence on the effect of microgravity on the brain-bone axis.

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