

Training Countermeasures in Astronauts Before, During and After Spaceflight Preventing Bone Loss and Osteoporosis

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Abstract

Introduction: Since the first human spaceflight took place in 1961, the effects of microgravity on the human body were studied considering astronauts' health and safety. Therefore, reduced gravity or microgravity and decreased forces, in space and planets surfaces, acting on astronauts' body producing multi- systemic dysfunctions, such as bone loss, muscle atrophy, cardiovascular changes, vestibular and sensory altering metabolic and nutritional status and dysregulation of the immune system.

Purpose: to review which training protocol before, during and after spaceflight can prevent bone loss and osteoporosis in astronauts.

Methods: Databases used are the website of the National Aeronautics Space Administration (NASA), the Medline and the website of the Queen Margaret University (QMU).

Results

According to these findings, astronauts' pre - flight prevention of bone losses, includes exercises at CEVIS, ARED and TVIS devices and nutrition. During their space travel, resistance exercise devices such as CEVIS, T2, ARED and TVIS in combination with dietary supplements and nutrition can prevent osteoporosis. Penn State 0 -G locomotion simulator and Kistler force platform can affect bone regulation. Astronauts' post -flight programme comprises T2, CEVIS and ARED, resistive and aerobic exercises and nutrition.

Conclusion

Pre -flight training countermeasures are TVIS, CEVIS and ARED. In -flight training, T2, TVIS, resistive exercises, aerobic training in ARED, TVIS, CEVIS, Kistler Gaitway treadmill and Penn State 0 - G locomotion simulator. Post -flight countermeasures contain dynamic stretching, warm-up, aerobic and resistance training, mobility and balance every, jumping drills, core exercise, static stretching. Moreover, resistance training in Flywheel Exercise Device and aerobic exercise in LBNP treadmill can be effective in astronauts' bones after their return to Earth.

Keywords: *training countermeasures, spaceflight, bone loss, osteoporosis*

Abbreviations: NASA, National Aeronautics Space Administration; NTRS, NASA Technical Reports Server; RANKL, Receptor Activator of Nuclear Factor κ B Ligand; OCL, osteoclast; JSC, NASA's Johnson Space Center; GCTC, Gagarin Cosmonaut Training Centre; EAC, European Astronaut Centre; CEVIS, Cycle Ergometer with Vibration Isolation System; ARED, the Advanced Resistance Exercise Device; TVIS, Treadmill Vibration Isolation System; ISS, the International Space Station;

Article Information

Conferece Proceedings: Global Congress on Physiotherapy, Physical Rehabilitation and Sports Medicine (Paris)

Conferece date: 18-19 November, 2019

[Inovineconferences.com](http://inovineconferences.com)

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Citation: Roussou E (2019) Training Countermeasures in Astronauts Before, During and After Spaceflight Preventing Bone Loss and Osteoporosis. J Health Sci Dev.

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