Challenges of Life Support/Medical Support for Human Missions (8)
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AN EVALUATION OF DIFFERENT EXERCISE COUNTERMEASURES TO PREVENT MUSCULOSKELETAL DECONDITIONING IN ANALOGUE ASTRONAUTS DURING LONG-TERM BED-REST

Abstract

Introduction

Protecting astronauts against the physiological effects of microgravity is key to the success of future space exploration missions. However, long duration missions pose new challenges as astronauts are confined to smaller habitable spaces for much longer and need to perform physically demanding surface tasks on reloading. At present, despite an intense exercise regime on the International Space Station astronauts still experience musculoskeletal deconditioning and must take part in reconditioning programmes on their return. In future, without more effective countermeasures being employed on route, astronauts may be unable to perform mission critical tasks on arrival.

Conducting experiments in space is challenging, so long-term bed-rest studies are used to allow researchers to test new ideas in simulated microgravity.

Aims and Methods

The aim of this review was to explore the three main types of exercise countermeasures tested in long-term bed-rest studies (resistance, aerobic, and vibration) to determine the efficacy and feasibility of different countermeasures for long duration missions.

The focus of this review was placed on long-term bed-rest studies and the musculoskeletal groups most affected by lack of weight bearing. 15 studies satisfied the inclusion criteria of bed-rest over 30 days and lower limb bone or muscle outcome measures. The following parameters were used to compare countermeasures: bone mineral density (BMD), bone mineral content (BMC), muscular cross-sectional area (mCSA), muscle strength and muscle volume.

Results

Resistive exercise on a vibrating platform (RVE) had the best overall effects on muscular function with preservation of mCSA, preservation of muscle strength and improvement of muscle volume. RVE also resulted in improvements in BMC but had no effect on BMD. However resistive exercise on an alternative device (Horizontal Exercise Machine) resulted in preservation of BMD.

Discussion

Coupling a vibrating footplate with a flywheel may be the space saving solution required to prevent musculoskeletal deconditioning during long duration missions. However, to ensure astronauts are able to perform physically demanding tasks on reloading, further work is needed to determine the ideal exercise dose and investigate any additional benefits of adjuncts to exercise such as pharmacotherapy.