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CREW CONDITIONING AND RECOVERY ON MARS USING AQUATIC THERAPY

Abstract

Sustaining human presence on Mars requires deconditioning from the long-duration transit in microgravity and mitigating physiological changes on the Martian surface due to a reduced-gravity environment. On Earth, there are land-based exercises that meet the musculoskeletal and cardiovascular system needs. However, applying the same practices on Mars is not feasible due to requirements of heavy equipment and tools and potential risk of injury from weight lifting or resistance band workouts. Additionally, these exercises have to be suitable for astronauts of all types. Aquatic therapy is a low-risk, low-impact solution that could address the physiological needs for sustaining a crew on the surface. As demonstrated in sports science, physical therapy, and post-injury rehabilitation, aquatic therapy relies on the natural resistance of water and buoyancy for building and maintaining strength and endurance. This research incorporated aquatic therapy's proven capability into a design concept that could be suitable for habitats on the Martian surface. The Aquapod design concept offers the capability for performing the necessary exercises as well as providing a user-friendly experience that promotes exercising through its design features, amenities, and overall appeal. The Aquapod design is based on three key areas of research: exercise performance, habitat system compatibility, and overall design requirements. Applying these criteria, this paper presents qualitative evaluations of three proposed design concepts: (1) Concept A: a deployable design that emphasizes minimizing dry mass, being portable, and deployable within the habitat floor area. (2) Concept B: a dedicated space which utilizes international standard payload rack (ISPR) compatibility therefore simplifying interface with water supply and reducing stress on habitat's life support systems. (3) Concept C: improved off the fixed design of Concept B by employing a design built into the floor structure allowing easier access, direct plumbing interfaces and low impact on habitat floor real estate. The paper also discusses feasibility of improving, integrating, and "Mars-rating" commercially off-the-shelf (COTS) products. In addition, presented design options addressed such challenges as maintaining an allocated water supply, preventing water loss and damage, and preserving habitat ambient atmosphere conditions.