

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)  
Human Physiology in Space (2)

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THE RUSSIAN SYSTEM OF COUNTERMEASURE TO NEGATIVE EFFECTS OF  
WEIGHTLESSNESS PROVIDES A SUFFICIENT LEVEL OF PERFORMANCE FOR A MARTIAN  
EXPEDITION**Abstract**

Prolonged stay in weightlessness is accompanied by significant changes in all body systems that are critical for human performance. The primary effects of weightlessness are the weight unloading of musculoskeletal system, and consequently, the general body asthenization, muscle mass loss, reduction in strength, endurance, physical performance. The purpose of the study was to evaluate the effectiveness of means and methods to counteract the negative effects of weightlessness and provide a sufficient level of performance during long space flights. A cosmonaut who completed a 355-day flight took part in the study. During the flight, there were two experimental periods of physical training, which were combined with training according to the Russian prevention system. The experimental periods involved the exclusion of treadmill training. In the first experimental period, the cosmonaut performed two training sessions per day with a "compensator of support unloading" for 3 days, in the second period, two trainings per

day on a bicycle ergometer for 13 days. Strength training sessions were during the experimental periods, and alternated every other day with a second training session on the experimental prevention means. The performance level was assessed with the locomotor test of individual strategies, the standard MO-3 test, isokinetic testing, and test including model operations of extra-vehicular activity on the surface. The locomotor test results showed the effectiveness of the training on a bicycle ergometer without using the treadmill for 13 days. The experimental scheme with "compensator of support unloading" led to an increase in the physiological cost of the load in the locomotor test. All model operations were successfully performed, in the locomotor test a running speed of 15 km per hour was achieved, which corresponds to the pre-flight indicators, but the physiological cost of working operations turned out to be slightly increased, and the moments of forces were reduced. A comprehensive analysis of the cosmonaut's performance after a long flight (comparable in time to a flight to Mars) can be assessed as sufficient for operator activities on the planet's surface. A change in the physiological cost of performing model operations was found. Short-term replacement of training on the treadmill with training on a bicycle ergometer will preserve physical performance and will prevent the monotony. "Compensator of support unloading" can only be recommended as an optional prevention tool. The work was supported by the Russian Science Foundation project and the basic funding of the Russian Academy of Sciences 63.1.