

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

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WAYS TO OPTIMIZE THE JOINT ACTION OF LOCOMOTION AND RESISTANCE TRAINING IN  
EXTENDED MISSIONS WITH ALLOWANCE FOR INDIVIDUAL PROFILES OF COSMONAUTS**Abstract**

Training on the treadmill is the pivot of the Russian system of in-flight countermeasures against the negative effects of microgravity. Besides, training on the bicycle ergometer alternates with resistive exercises and passive means. At present, we are in search of optimal resistive training regimens targeted predominantly at the strength endurance development. Russian specialists advocate the production of training loads by numerous exercise repetitions (from 12 to 16) utilizing lighter weights (60% of a repeated maximum) as they are less risky. Effectiveness of running on the treadmill depends mainly on the next three factors: training regularity, portion of the passive running in the total training time and level of the axial loading. To optimize cosmonauts' training regimens on the treadmill, individual regimens of 18 cosmonauts in daily training sessions were rated with consideration of the three factors which, in their turn, were given scores from 1 to 10. Preventive effectiveness of the locomotion training was evaluated in space flight (MO-3 test with incremental loading) and after return (EMG cost of walking). Significance of each factor was verified experimentally. The group of cosmonauts with the high score sum (n=9) differed fiducially from the group with the low score sum (n=9) by a small physiological cost of loads during space flight ( $p<0.01$ ); the post-flight neurophysiological status of m. soleus in the former was close to preflight ( $p<0.02$ ). It was also shown that physical performance in space flight may remain high provided the axial loading and passive running regimens are controlled within predetermined margins. Role of the resistive exercises with different load levels was analyzed in the group of cosmonauts who had the largest score sum for all three factors (n=8). Changes in strength endurance and facilitation of maximum voluntary force of leg muscles were tested on return from space mission. Based on the results of isokinetic testing, cosmonauts who performed four repetitions rather than three with the analogous weight loading of approx. 60% of a repeated maximum suffered less losses in strength endurance equally of femoral flexors ( $p<0.05$ ) and extensors ( $p<0.04$ ), and less reductions of maximum voluntary force of the lower leg flexors ( $p<0.05$ ). In conclusion, the results of the investigation suggest combinations of locomotion and resistive exercises for cosmonauts' training in long-duration missions can be designed by playing with the three factors depending on the individual physical profile of a cosmonaut. The work was carried out with support of RFFI grant No.13-04-02182.