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CHANGES IN AEROBIC FITNESS AND MUSCLE BLOOD FLOW RELATIONSHIPS TO EXERCISE COUNTERMEASURES ON ISS

Abstract

Exercise countermeasures are a standard requirement for all astronauts living for extended periods on the International Space Station. While the exercise performed by each astronaut is intended to include aerobic activities on the treadmill (T2) and cycle (CEVIS) as well as resistance exercises on Advanced Resistive Exercise Device (ARED), the absolute volume and intensity is determined by personal preference. Recent reports from Moore and colleagues revealed that aerobic fitness measured by peak aerobic power or maximal oxygen uptake (VO2max) decline markedly early after arrival on ISS but recover toward pre-flight values with a subsequent reduction immediately after return to Earth. Another index of local muscle fitness can be obtained by quantifying the rate at which blood flow recovers after a bout of exercise. In these studies that are part of the Vascular Echo experiment, we monitored blood flow from the superficial femoral artery by Doppler ultrasound (PDOP, CNES) with the audio signal processed to yield the outer velocity envelope beat-to-beat after stopping 1-minute with 30 repeated plantar flexions against a rubber band held at a defined stretch. A 3-parameter single exponential decay model fitted the data, and the time constant was taken as an index of the rate of recovery. VO2max was estimated for all astronauts from the cycle ergometer work rate to VO2 relationship. Nine astronauts (2 women) on ISS between 127 and 204 days accumulated a total of 1998 (range 1861 – 8072) minutes of aerobic exercise and a total of 193587 (range 87027 – 626494) pounds of leg-specific resistance exercise. VO2max decreased from 52.5 (5.8) to 49.5 (6.0) ml/kg/min (P=0.034) while the leg blood flow recovery time constant was not changed 24.0 (9.4) to 25.2 (7.7) s. There was a positive relationship between change in VO2max and time constant (r2=0.47). These results reveal large between astronaut differences in the volume and intensity of exercise performed on ISS. The larger reductions in aerobic fitness were generally observed in astronauts who completed the lowest volume of exercise, but there were exceptions. Supported by Canadian Space Agency and CNES.