Decline in Aerobic Fitness after Long-Term Stays on the International Space Station
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U.S. and non-Russian International Partner astronauts who participate in long-term International Space Station (ISS) expeditions perform submaximal cycle exercise tests before, during, and after space flight. The heart rate (HR) and oxygen uptake (VO2) responses to exercise are used to estimate peak VO2 (EVO2pk).

Purpose: To determine if the following factors are associated with the preflight-to-post flight change in EVO2pk: gender, age, body weight (BW), number of aerobic exercise sessions/wk during flight, length of flight, EVO2pk measured before and late during the flight, ISS Expedition number and time between landing and the first post flight test.

Methods: Records of 37 ISS astronauts (30 ♂, BW=81.6±8.6 kg; 7 ♀, BW=66.1±4.9 kg [mean±SD]), age 46±4 years, were retrospectively examined. Peak HR and VO2 were measured ∼9 months before flight to establish the test protocol. The submaximal cycle test consisted of three 5-minute stages designed to elicit 25, 50, and 75% of VO2pk. EVO2pk was calculated using linear least-squares extrapolation of average HR and VO2 during the last minute of each stage to predict VO2 at maximal HR. VO2 was not measured during flight and was assumed to not be different from preflight. Testing was performed ∼45 days before launch, late during flight, and during the week after landing. A random-intercept multivariate model was used to determine which characteristics significantly contributed to post flight EVO2pk.

Results: In-flight aerobic exercise averaged 5.4±1.2 sessions/wk. ISS flight duration averaged 163±39 d. Mean EVO2pk values were 3.41±0.64 L·min⁻¹ before flight, 3.09±0.57 L·min⁻¹ late in flight, and 3.02±0.65 L·min⁻¹ after flight. Late- and after-flight values were lower (p<0.05) than preflight values and did not differ from each other. Time between landing and post flight testing was 4.5±1.6 days. The only factor significantly associated with the post flight EVO2pk value was the late-flight EVO2pk score.

Conclusion: Testing performed late during a mission provides a prediction of EVO2pk after landing. This approach may be implemented during longer missions.