

OXYGEN UPTAKE RESPONSES TO SUBMAXIMAL EXERCISE LOADS DO NOT CHANGE DURING LONG-DURATION SPACE FLIGHT

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INTRODUCTION

In previous publications we have reported that the heart rate (HR) responses to graded submaximal exercise tests are elevated during long-duration International Space Station (ISS) flights [1]. Furthermore, the elevation in HR appears greater earlier, rather than later, during the missions. A potential confounder in the interpretation of HR results from graded exercise tests on ISS is that the cycle ergometer used (CEVIS) is vibration-isolated from the station structure. This feature causes the CEVIS assembly to sway slightly during its use and debriefing comments by some crewmembers indicate that there is a “learning curve” associated with CEVIS use. Therefore, one could not exclude the possibility that the elevated HRs experienced in the early stages of ISS missions were related to a lowered metabolic efficiency of CEVIS exercise that would raise the submaximal oxygen uptake (VO_2) associated with graded exercise testing work rates.

PURPOSE

To determine if VO_2 values associated with submaximal graded exercise test work rates differ when early versus late in flight data are compared.

METHODS

Six astronauts (3 M, 3 F: 48 ± 6 yr, 173 ± 7 cm, 77.1 ± 19.6 kg [mean \pm SD]) participating in the ISS $\text{VO}_{2\text{max}}$ study performed cycle exercise tests on the CEVIS early (flight day (FD) 18 ± 3) and late (FD 150 ± 9) during their missions. Tests consisted of three 5-min stages designed to elicit 25%, 50%, and 75% of preflight $\text{VO}_{2\text{max}}$. VO_2 was measured using the ISS portable pulmonary function system (PPFS) (Damec, Odense, Denmark). VO_2 data from minutes 3–4 of each 5-min exercise stage were used for statistical comparison and the data from the early and late flight tests were analyzed with repeated-measures Analysis of Variance.

RESULTS

The results are contained in the table below.

Stage (% of preflight maximum)	VO_2 (L/min) Early Flight	VO_2 (L/min) Late Flight
25%	0.78 ± 0.18	0.75 ± 0.09
50%	1.43 ± 0.33	1.45 ± 0.32
75%	2.15 ± 0.52	2.23 ± 0.60

VO_2 increased with increasing exercise stage in both test sessions, which is the normal response to graded exercise. However, there was no evidence of VO_2 differing between the early and late flight tests ($P = 0.60$), nor was there a significant interaction between stages and sessions ($P = 0.27$).

DISCUSSION

The finding of no differences in submaximal VO_2 between the first and last tests conducted during flight indicate that any “learning curve” associated with CEVIS occurring during flight does not influence the metabolic cost of submaximal exercise, at least in the range of flight dates examined for these subjects. Based on the results of the present analysis there is no evidence to suggest that the changes in submaximal exercise HR previously reported during ISS flight are related to alterations in submaximal exercise VO_2 across test sessions.

REFERENCES

[1] Moore AD, Lee SMC, Stenger MB, Platts SH. (2010). *Acta Astronautica* 66:974-998.