Improving the Accuracy of Predicting Maximal Oxygen Consumption (VO_2pk)

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Maximal oxygen (VO_2pk) is the maximum amount of oxygen that the body can use during intense exercise and is used for benchmarking endurance exercise capacity. The most accurate method to determineVO_2pk requires continuous measurements of ventilation and gas exchange during an exercise test to maximal effort, which necessitates expensive equipment, a trained staff, and time to set-up the equipment. For astronauts, accurate VO_2pk measures are important to assess mission critical task performance capabilities and to prescribe exercise intensities to optimize performance. Currently, astronauts perform submaximal exercise tests during flight to predict VO_2pk; however, while submaximal VO_2pk prediction equations provide reliable estimates of mean VO_2pk for populations, they can be unacceptably inaccurate for a given individual. The error in current predictions and logistical limitations of measuring VO_2pk, particularly during spaceflight, highlights the need for improved estimation methods. **Purpose:** To evaluate the accuracy of predicting VO_2pk on an individual level in astronauts and in bed rest subjects by using data from previous VO_2pk tests where metabolic gas analysis was performed, resting heart rate (HR), and peak workload. **Methods:** Data from the *'CFT70 bed rest Study'* (150 test sessions, 24 subjects) and the '*In-flight VO_2max Study'* (101 test sessions, 14 subjects) were used to determine whether peak workload, resting HR, and measured VO_2pk obtained from one or more previous peak cycle tests (with metabolic gas analysis) could be used in a regression or ratio model to accurately predict VO_2pk for a later peak test without gas analysis. Subject-specific ratio and regression models were evaluated on their ability to predict VO_2pk for individuals on a later peak cycle test that occurred during or post-bed rest or spaceflight. Accuracy was evaluated based on average absolute relative error (RE). **Results:** Regression models with both peak workload and resting HR as predictors were no more accurate than the simple ratio estimate (VO_2 : workload). Using the ratio method, predictions during and after spaceflight were more accurate with two previous measurements of VO_2pk compared to only one. In-flight RE with one previous test was 9.0% (95% CI: 4.9% – 13.1%) and was reduced to 6.4% (95% CI: 4.2% – 8.7%) with two previous tests. Similar results were observed for prediction at the post-flight (R+0) test. Prediction accuracy during bed rest was best with 3 previous measured VO_2pk test sessions (*RE* = 10.2%, 6.2%, 5.0% for 1, 2, and 3 previous tests, respectively). Post-bed rest (BR+0) prediction accuracy was 6.0% (95% CI: 4.1% – 8.0%) and did not improve with more than one previous test. **Conclusion:** Including data from previous measurements of VO_2pk significantly reduced the variability in predicting VO_2pk for individuals and reduced average RE to less than 10%. These data may useful for development of better assessments of aerobic capacity using combinations of max tests with and without gas analysis. .