WEB-ONLY DATA SUPPLEMENT

Oxygen uptake kinetics during continuous exercise

In addition to the continuous exercise (CE) and intermittent exercise (IE) bouts, seven subjects performed 1 or 2 additional constant-load transitions to 70% of peak power. The protocol for these additional exercise bouts involved 3 min of unloaded cycling followed by an abrupt application of the predetermined workload for 7 min. The breath-by-breath oxygen uptake ($\dot{V}_{O_2}$) data from each trial (including the first 7 min of the CE bout) were inspected for aberrant breaths. Values exceeding 3 standard deviations from the local mean were removed. The $\dot{V}_{O_2}$ data from the repeated trials were then interpolated to 1 second values, time aligned and averaged, effectively smoothing the data and enhancing the underlying kinetic response. A four-compartment model with three exponential terms was used to describe the time course of the $\dot{V}_{O_2}$ response (Equation 1):

$$\dot{V}_{O_2}(t) = A_B + A_C(1 - e^{-(t-TD_C)/\tau_C}) + A_P(1 - e^{-(t-TD_P)/\tau_P}) + A_S(1 - e^{-(t-TD_S)/\tau_S}),$$

where $\dot{V}_{O_2}(t)$ is the $\dot{V}_{O_2}$ at time t; A_B is the baseline $\dot{V}_{O_2}$ during unloaded cycling, while A_C, A_P and A_S represent the cardio-dynamic (phase I), primary (phase II) and slow component amplitudes, respectively; TD_C, TD_P and TD_S, and τ_C, τ_P and τ_S are the time delays and time constants of phase I and the primary and slow components, respectively.

If the amplitude of the slow component (A_S) was not significantly different from 0, the model was reduced to three compartments with exponential terms describing phase I and phase II (Equation 2):

$$\dot{V}_{O_2}(t) = A_B + A_C(1 - e^{-(t-TD_C)/\tau_C}) + A_S(1 - e^{-(t-TD_S)/\tau_S})$$

Figure 1 shows an example of the $\dot{V}_{O_2}$ response and model fit in a representative subject with chronic obstructive pulmonary disease (COPD) and Table 1 provides the individual and group mean values for selected model parameters.

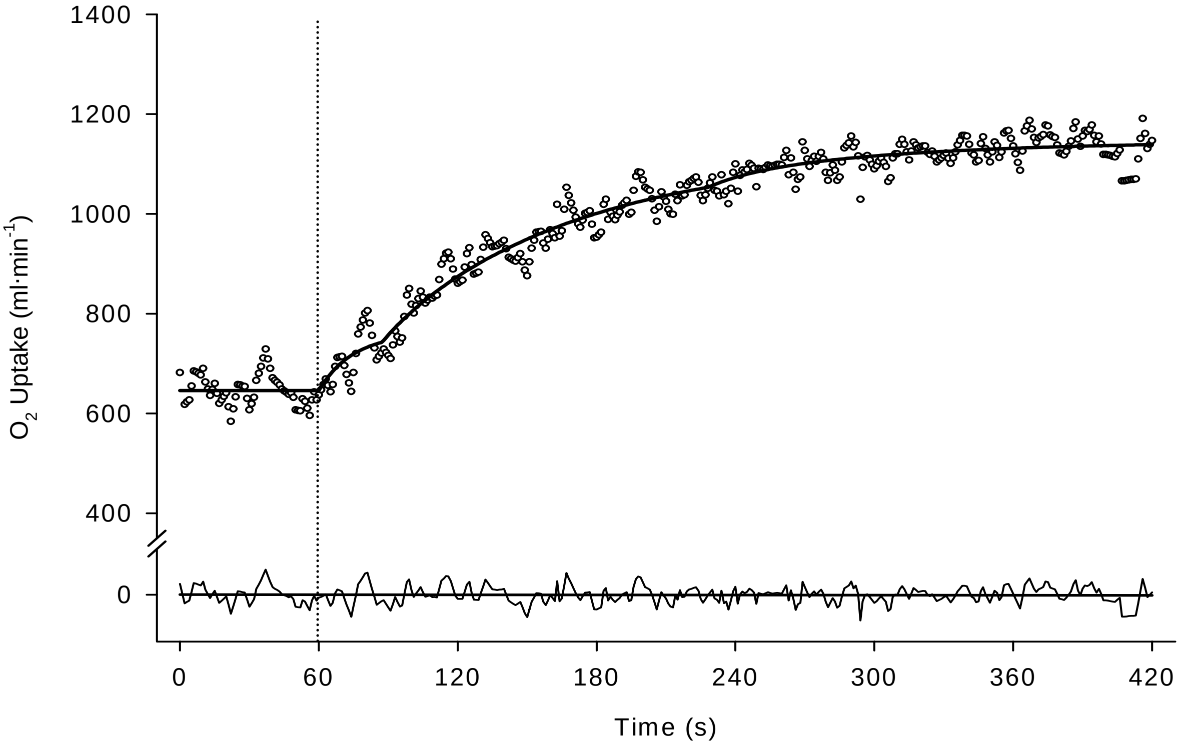

Figure 1. $\dot{V}_{O_2}$ response to constant-load exercise in a representative subject. Data points represent mean second-by-second values for 2 transitions to 70% of peak power. The solid line indicates the model fit, with the residuals shown at the bottom. The pre-determined workload was applied at 60 s. The $\dot{V}_{O_2}$ values from 0 to 60 s are for unloaded cycling.

Table 1: Oxygen uptake kinetics in the transition to constant-load exercise performed at 70% of peak power in patients with moderate COPD.

Subjects	A_B (ml/min)	A_C (ml/min)	A_P (ml/min)	A_S (ml/min)	τ_P (s)	TD_P (s)	TD_S (s)
1	555	24	310	59	86	9	217
2	580	53	324	55	64	25	224
3	477	19	146	--	97	32	--
4	646	115	361	24	85	27	141
5	551	47	352	26	74	26	229
6	714	127	581	--	115	22	--
7	747	158	663	80	55	8	174
Mean (SE)	**610 (37)**	**78 (21)**	**391 (66)**	**49 (11)**	**82 (8)**	**21 (3)**	**197 (17)**

A_B: baseline oxygen uptake amplitude; A_C: phase I amplitude; A_P: phase II amplitude; A_S: slow component amplitude; τ_P: phase II time constant; TD_P: phase II onset time; TD_S: slow component onset time.

The effect of $\dot{V}_{O_2}$ kinetics on the intermittent exercise response

To determine if the lower $\dot{V}_{O_2}$ response observed during IE compared to CE was primarily the result of the exponential shape of the on-kinetic response, we used a similar methodology to that recently described by Morris and colleagues.[1] Briefly, we calculated the $\dot{V}_{O_2}$ amplitude at 60 s of CE and compared this value with the measured IE response (Table 2). The $\dot{V}_{O_2}$ amplitude for IE was determined as the average $\dot{V}_{O_2}$ measured during the final 10 s of each 60-s exercise interval over the duration of the entire IE bout. The predicted $\dot{V}_{O_2}$ value was calculated using a single exponential term, omitting the Phase I response (Equation 3):

$$\dot{V}_{O_2}(t) = A_B + A_P(1 - e^{-(t - TD_P)/\tau_P})$$

The $\dot{V}_{O_2}$ amplitude at 60 s was also re-calculated using a time constant (τ_P) value of 42 s. This value is the mean phase II τ for healthy older individuals performing constant-load cycling at ~70% of peak power.[2]

Table 2. Measured and predicted oxygen uptake values for intermittent exercise.

Subjects	Measured $\dot{V}_{O_2}$ (l/min)	Predicted $\dot{V}_{O_2}$ (l/min)	Predicted $\dot{V}_{O_2}$ (l/min)
		τ_P from Table 1	τ_P = 42 s
1	0.76	0.72	0.81
2	0.78	0.79	0.87
3	0.88	0.89	1.01
4	0.77	0.75	0.85
5	1.05	1.29	1.37
6	0.97	1.00	1.25
7	0.50	0.54	0.60
Mean (SE)	**0.82 (0.07)**	**0.85 (0.09)**	**0.97 (0.10)***

$\dot{V}_{O_2}$: oxygen uptake; τ_P: phase II time constant . The measured $\dot{V}_{O_2}$ values represent the mean end-exercise interval values obtained over the entire intermittent exercise test duration. The predicted $\dot{V}_{O_2}$ values were calculated using a single-term (Equation 3) exponential model (see text for details). * $P<0.05$, significantly different from measured $\dot{V}_{O_2}$ value (repeated measures ANOVA).

REFERENCES

1 **Morris N**, Gass G, Thompson M, *et al.* Physiological responses to intermittent and continuous exercise at the same relative intensity in older men. *Eur J Appl Physiol* 2003;**90**:620-625.

2 **Sabapathy S**, Schneider DA, Comadira G, *et al.* Oxygen uptake kinetics during severe exercise: a comparison between young and older men. *Respir Physiol Neurobiol* 2004;**139**:203-213.