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Monitoring pulmonary VO_2 on-kinetics during a 2.5-year period in competitive youth cyclists

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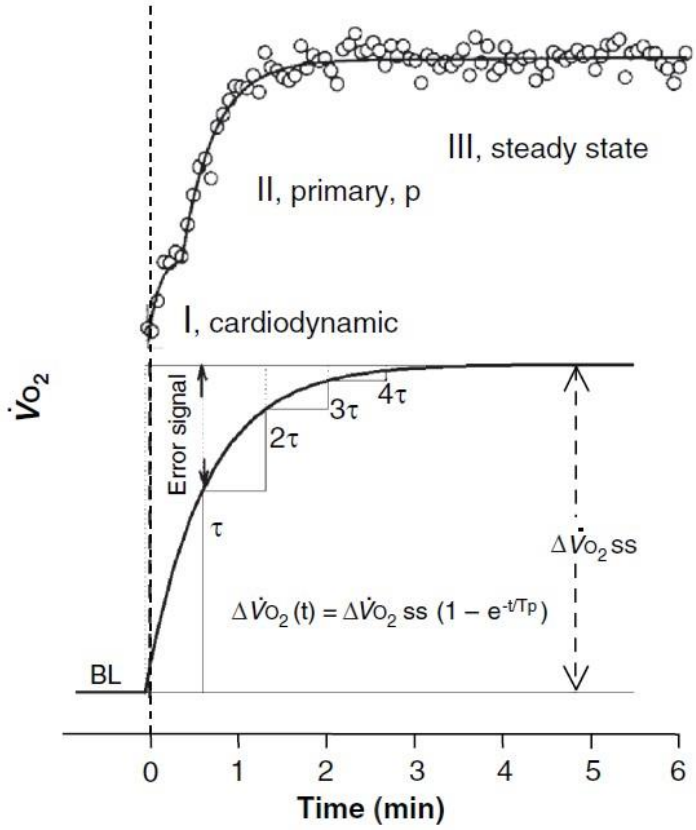
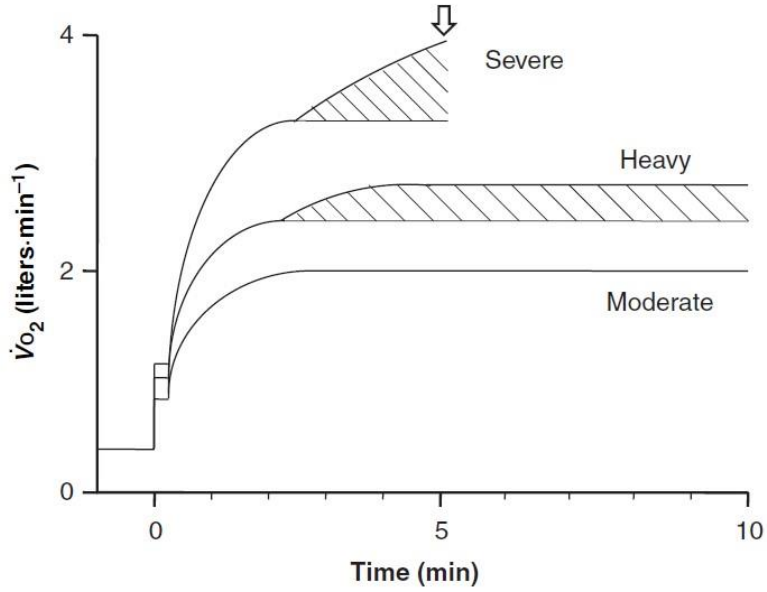
General information:





(Poole and Jones, 2012)

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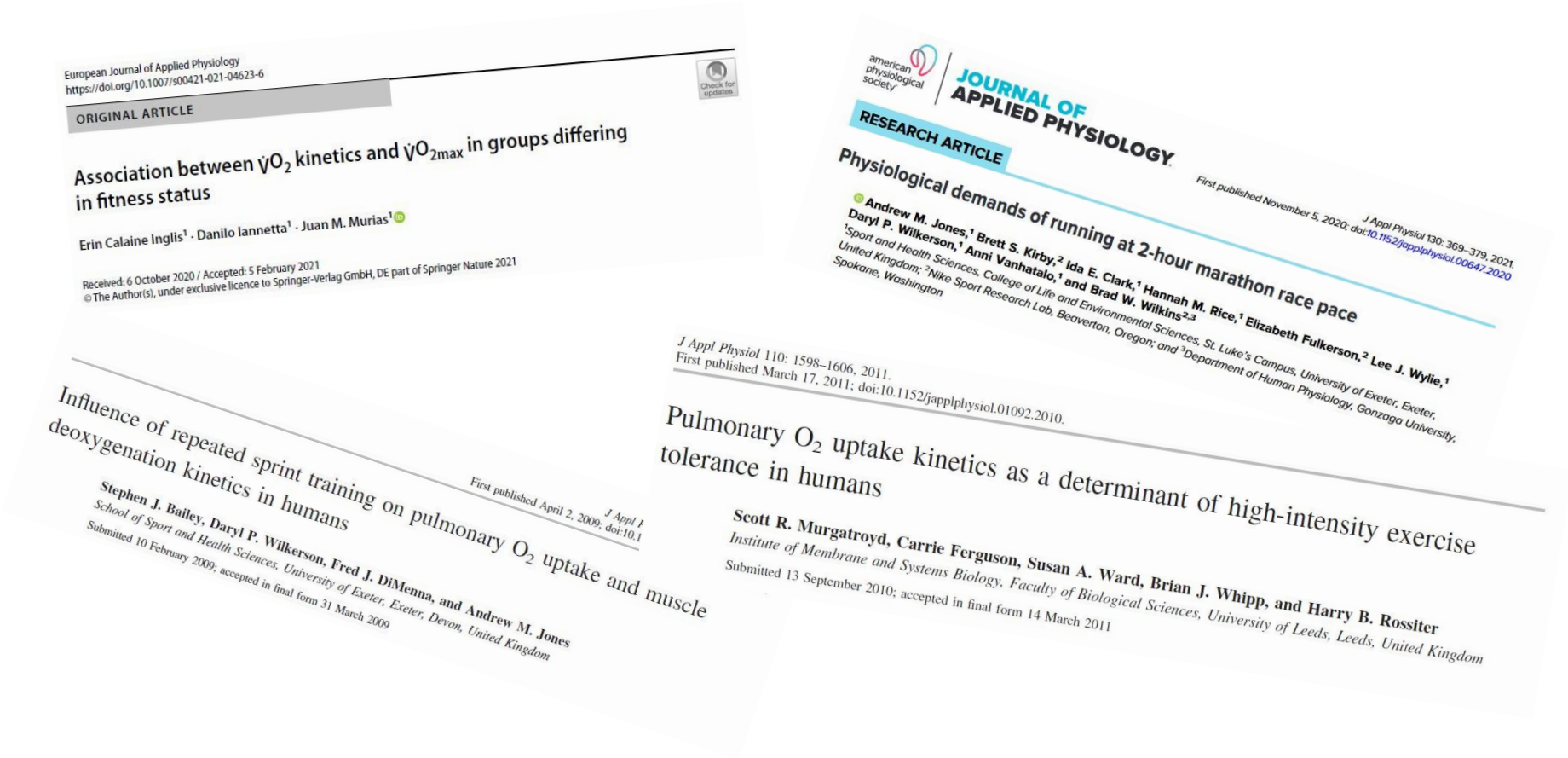
Why could VO_2 on-kinetics be interesting for endurance performance?



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ORIGINAL ARTICLE

Association between $\dot{V}O_2$ kinetics and $\dot{V}O_{2max}$ in groups differing in fitness status

Erin Calaine Inglis[1] · Danilo Iannetta[1] · Juan M. Murias[1]

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RESEARCH ARTICLE

Physiological demands of running at 2-hour marathon race pace

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Andrew M. Jones,[1] Brett S. Kirby,[2] Ida E. Clark,[1] Hannah M. Rice,[1] Elizabeth Fulkerson,[2] Lee J. Wylie,[1] Daryl P. Wilkerson,[1] Anni Vanhatalo,[1] and Brad W. Wilkins[2,3]

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Influence of repeated sprint training on pulmonary O_2 uptake and muscle deoxygenation kinetics in humans

First published April 2, 2009; doi:10.1

Stephen J. Bailey, Daryl P. Wilkerson, Fred J. DiMenna, and Andrew M. Jones

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Submitted 10 February 2009; accepted in final form 31 March 2009

J Appl Physiol 110: 1598–1606, 2011.
First published March 17, 2011; doi:10.1152/japplphysiol.01092.2010.

Pulmonary O_2 uptake kinetics as a determinant of high-intensity exercise tolerance in humans

Scott R. Murgatroyd, Carrie Ferguson, Susan A. Ward, Brian J. Whipp, and Harry B. Rossiter

Institute of Membrane and Systems Biology, Faculty of Biological Sciences, University of Leeds, Leeds, United Kingdom

Submitted 13 September 2010; accepted in final form 14 March 2011

(Bailey et al., 2009; Inglis et al., 2021; Jones et al., 2020; Murgatroyd et al., 2011)

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Why could VO_2 on-kinetics be interesting for endurance performance?

VO_2 time constant – O_2 debt

VO_2 slow component - recruitment of less efficient muscle fibres

(high intensity) exercise tolerance and endurance performance

(Jones and Koppo, 2005; Jones and Poole, 2005)

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- Time constant increases with aging and/or maturation
- Slow component increases with aging and/or maturation

} Reduced exercise tolerance

Aim:

- To investigate longitudinal changes of the VO_2 on-kinetics in response to moderate- and heavy-intensity exercise in a group of competitive youth cyclists

(Armstrong and Barker, 2009; Breese et al., 2010, Fawkner and Armstrong, 2004; Fawkner et al., 2002; Leclair et al., 2012;McNarry, 2019)

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Participants:

- N = 9 male and female competitive youth cyclists
- Training history of 2 to 5 years
- Regular endurance training volume of ~10 h per week
- Training volume maintained/increased during the study

Study design:

- Two lab visits in Feb-2017, May-2018 and Sep-2019
- Anthropometric measures
- Ramp incremental test (20 $W.min^{-1}$)
- Two constant-workrate step-transitions
    - Moderate intensity
    - Heavy intensity

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Constant-workrate transitions:

- 3 min baseline at 40 W
- 6 min at WR 90% VT (moderate intensity)
- 8 min recovery at 40 W
- 6 min at WR $\Delta 50$ %[1] (heavy intensity)
- 90 to 100 rpm
- Pulmonary ventilation and gas exchange measured breath-by-breath
- Parameter estimates of the VO_2 on-kinetic response – single exponential model

Analysis:

- Repeated measures ANOVA and Tukey's post-hoc tests
- Statistical significance: $p < 0.05$

[1] $\Delta 50\ \% = VT + (W_{max} - VT) * 0.5$

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Participants characteristics:

Participant characteristics (mean ± SD)

	Feb-2017	May-2018	Sep-2019
No. of participants	9	9	9
Age (y)	14.5 ± 1.1	15.7 ± 1.0	16.7 ± 1.2
Stature (cm)	165.3 ± 12.5	170.7 ± 11.4	175.0 ± 11.0
Body mass (kg)	53.9 ± 12.7	59.1 ± 11.7	64.0 ± 11.1
$\dot{V}O_{2peak}$ ($mL \cdot min^{-1} \cdot kg^{-1}$)	62.6 ± 4.2	61.1 ± 4.6	68.4 ± 7.6 *, $

significance values determined from Tukey's post-hoc test; * significantly different from 2017; $ significantly different from 2018; VO_{2peak} = maximum oxygen uptake

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Moderate-intensity transition:

Pulmonary oxygen uptake on-kinetic parameters during moderate intensity exercise (mean ± SD)

	Feb-2017	May-2018	Sep-2019
Workrate (W)	127 ± 27	135 ± 30	170 ± 34 *, $
Phase II $\dot{V}O_2$ amplitude ($mL \cdot min^{-1}$)	702 ± 306	715 ± 306	1236 ± 398 *, $
Phase II $\dot{V}O_2$ gain ($mL \cdot min^{-1} \cdot W^{-1}$)	10.5 ± 1.1	9.4 ± 1.0	11.3 ± 1.1 $
Phase II $\dot{V}O_2$ time delay (s)	11.8 ± 5.5	14.5 ± 4.5	8.3 ± 5.0
Phase II $\dot{V}O_2$ time constant (s)	23.1 ± 7.7	11.4 ± 5.7 *	14.1 ±5.0 *
$\dot{V}O_2$ MRT (s)	34.9 ± 3.1	25.9 ± 7.8 *	22.4 ± 7.1 *

significance values determined from Tukey's post-hoc test; * significantly different from 2017; $ significantly different from 2018; MRT = mean response time

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Heavy-intensity transition:

Pulmonary oxygen uptake on-kinetic parameters during heavy intensity exercise (mean ± SD)

	Feb-2017	May-2018	Sep-2019
Workrate (W)	218 ± 44	243 ± 48 *	279 ± 51 *, $
Phase II $\dot{V}O_2$ amplitude ($mL \cdot min^{-1}$)	1664 ± 538	1827 ± 483	2333 ± 600 *, $
Phase II $\dot{V}O_2$ gain ($mL \cdot min^{-1} \cdot W^{-1}$)	10.4 ± 0.8	10.0 ± 0.5	10.6 ± 0.6
Phase II $\dot{V}O_2$ time delay (s)	6.1 ± 3.3	5.8 ± 2.8	6.4 ± 4.5
Phase II $\dot{V}O_2$ time constant (s)	34.7 ± 3.6	29.3 ± 4.2 *	25.3 ± 5.8 *
$\dot{V}O_2$ MRT (s)	40.8 ± 2.3	35.1 ± 3.4 *	31.7 ± 4.3 *
$\dot{V}O_2$ slow component (mL)	98 ± 67	105 ± 60	165 ± 63
$\dot{V}O_2$ slow component (%)	5.7 ± 3.5	5.8 ± 2.8	7.3 ± 3.2

significance values determined from Tukey's post-hoc test; * significantly different from 2017; $ significantly different from 2018; MRT = mean response time

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- Speeding of the VO_2 time constant during moderate- and heavy-intensity exercise
  - In contrast to untrained youth
- No changes of the VO_2 slow component during heavy-intensity exercise
  - In contrast to untrained youth

- VO_2 time constant (moderate-intensity) of ~11 to 14 s in May-2018 and Sep-2019
  - Extremly short – steady-state within ~55 s
  - Values are similar with reported VO_2 time constants in highly trained adult endurance athletes
  - Suggesting a high potential for oxidative phosphorylation during moderate-intensity exercise

(Jones et al., 2020; Jones and Poole, 2005; McNarry, 2019; Poole and Jones, 2012)

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- Dissociation between the increase in VO_{2peak} and the decrease of the VO_2 time constant during moderate- and heavy-intensity exercise
  - Suggests different regulatory mechanisms
  - Sensitivity to different training sessions/programs different

(Jones and Koppo, 2005; Poole and Jones, 2012)

Thank you for your attention

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Thanks to my colleagues:

- Alfred Nimmerichter
- Bernhard Prinz
- Manfred Zöger
- Clemens Rumpl

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