



# Physiological Demands of Indoor Wall Climbing in Children

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# Introduction

- Regular physical activity and exercise are associated with numerous physical and mental health benefits in men, women and children
  - intrinsically interesting activities
  - encourage lifelong participation
  - maintaining of aerobic fitness

➤  **$\dot{V}O_2$  consumption** during various climbing protocols at between **20 - 45 ml·kg<sup>-1</sup>·min<sup>-1</sup>**

→ locomotion pace

→ climbing difficulty

→ steepness of the wall

→ climbing style

→ climbing ability

## Oxygen Uptake and Energy Expenditure for Children During Rock Climbing Activity

Phillip Baxter Watts and Megan L. Ostrowski  
Northern Michigan University

- in children aged  $10.9 \pm 1.7$  years
- continuous traverse and interval traverse
- climbing ~ easy jogging
- peak oxygen consumption **sustained**  $31.8 \pm 7.2 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  **climbing**  
**interval**  $27.3 \pm 6.2 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$

**The aim of the study was to assess  
the physiological demands of sport climbing  
in children.**

# Participants

- 25 children (aged 8–12 years)
- climbing performance IV to V+ RP (UIAA)
- climbing experience ~ 1.5 years

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	Boys (n = 12)	Girls (n = 13)
Body mass (kg)	29.7 ± 5.6	33.6 ± 9.4
Height (cm)	134.3 ± 8.5	138.3 ± 10.8
Body fat (%)	9.5* ± 1.9	17.5* ± 2.9

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\* significant differences between boys and girls p<0.05



# Energy expenditure measurement

- portable gas analyser (MetaMax 3B, Cortex, Germany)
- averaged every 20 seconds
- caloric equivalent of 20.9 kJ (Bertuzzi et al., 2007; Mermier et al., 1997; Rodio, et al., 2008)



# Climbing protocol

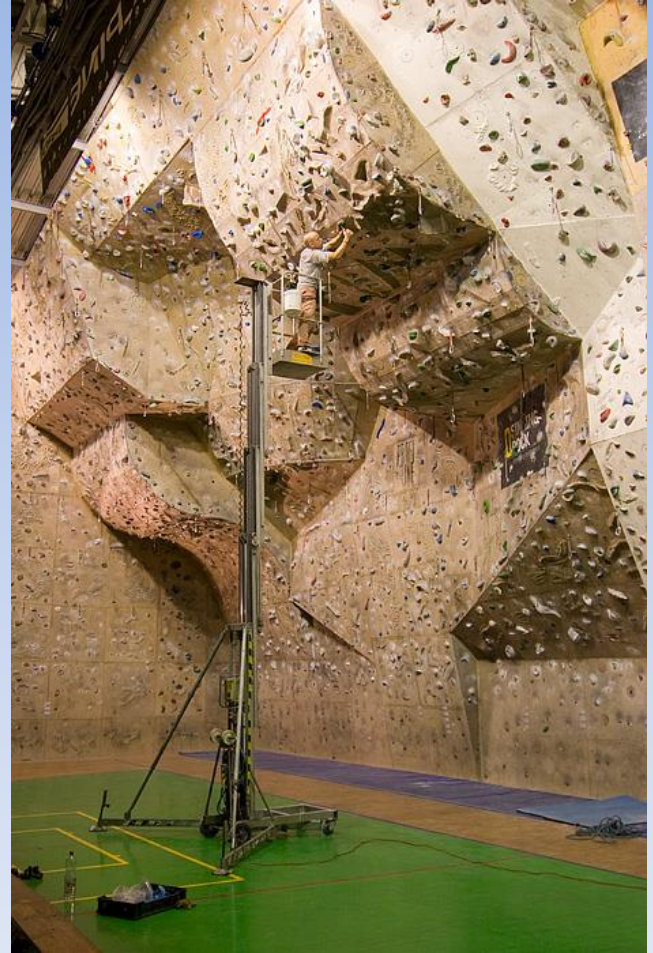
- 9.8 m high for the vertical (90°) route (N=25)  
10.0 m for the overhanging (110°) route (N=12)
- difficulty and profile of the routes → preferred routes  
→ discussion

vertical route - IV UIAA, 5.4 YDS, 4a Sport/French  
overhanging route - IV+ UIAA, 5.5 YDS, 4b Sport/French

- the time spent by climbing was registered during the 8 following week's period in all children







## Before and after climbing



## During climbing



# Data analysis

- descriptive statistics (mean and standard deviation)
- t-test for independent samples (boys x girls)
- significance level was set to  $P = 0.05$

# Results

Variables	Vertical route		Overhanging route	
	Boys (n=13)	Girls (n=12)	Boys (n=6)	Girls (n=4)
$\dot{V}O_{2\text{peak}}$ (l·min <sup>-1</sup> )	1.17 ± 0.22	1.24 ± 0.33	1.26 ± 0.30	1.27 ± 0.16
$\dot{V}O_{2\text{peak}}$ (ml·kg <sup>-1</sup> ·min <sup>-1</sup> )	39.6 ± 4.4	37.1 ± 4.5	42.8 ± 2.5	40.5 ± 5.6
$\dot{V}_E$ (l·min <sup>-1</sup> )	33.0 ± 4.8	34.7 ± 8.7	37.4 ± 6.3	38.9 ± 10.0
RER	0.91 ± 0.01	0.91 ± 0.06	0.95 ± 0.09	0.99 ± 0.05
HR <sub>peak</sub> (beats·min <sup>-1</sup> )	170 ± 15	180 ± 9	176 ± 21	190 ± 14
% of HR <sub>max</sub> (%)	81 ± 7	86 ± 5	84 ± 10	90 ± 7
Energy expenditure (kJ·min <sup>-1</sup> )	24.5 ± 4.7	25.9 ± 7.0	26.3 ± 6.3	26.5 ± 7.3
Energy expenditure (kJ·min <sup>-1</sup> ·kg <sup>-1</sup> )	0.82 ± 0.16	0.77 ± 0.21	0.89 ± 0.26	0.79 ± 0.23
Energy expenditure (kJ·m <sup>-1</sup> ·kg <sup>-1</sup> )	0.15 ± 0.03	0.14 ± 0.04	0.19 ± 0.05	0.20 ± 0.06
Time of climbing (min)	3.6 ± 0.8	3.7 ± 1.1	4.2 ± 0.9	5.2 ± 0.1

Climbed distance (m) boys	293 ± 194
Climbed distance (m) girls	279 ± 79
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Climbed distance (m) vertical route	275 ± 124
Climbed distance (m) overhanging route	301 ± 173

The average time spent by climbing in the training session (60 minutes) during the 8 weeks period was **11.3 ± 4.3 min.**



# Discussion

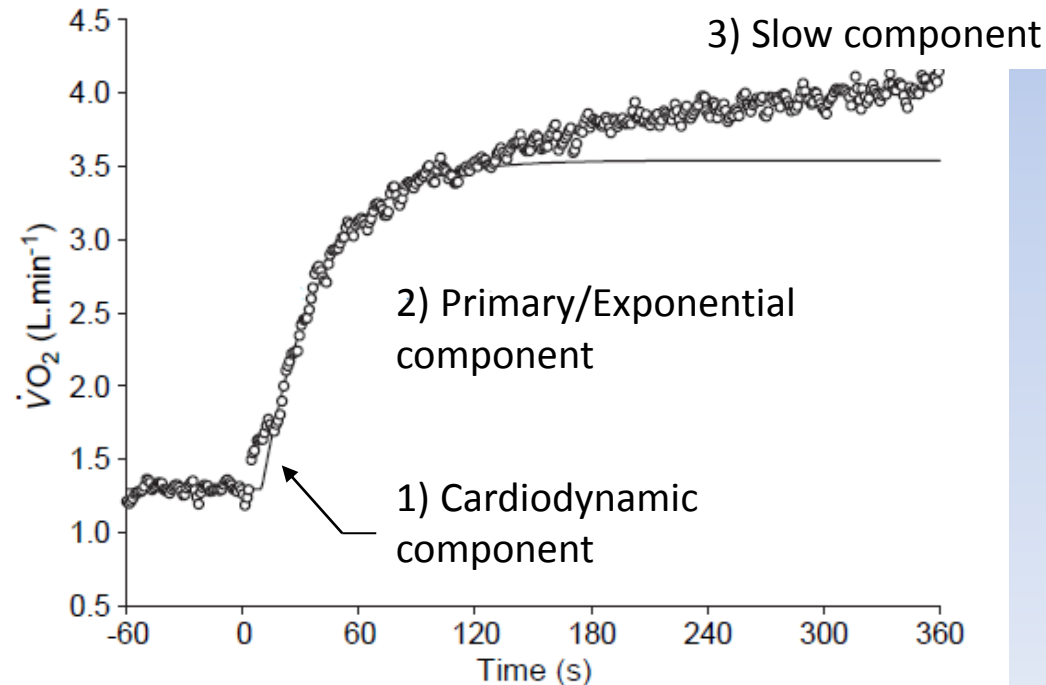
## Assessing energy expenditure

- average  $\dot{V}O_2$  X peak  $\dot{V}O_2$
- anaerobic component was not evaluated
- Steady-state conditions in  $\dot{V}O_2$  are necessary for the correct evaluation of energy expenditure

# Oxygen uptake kinetics as a determinant of sports performance

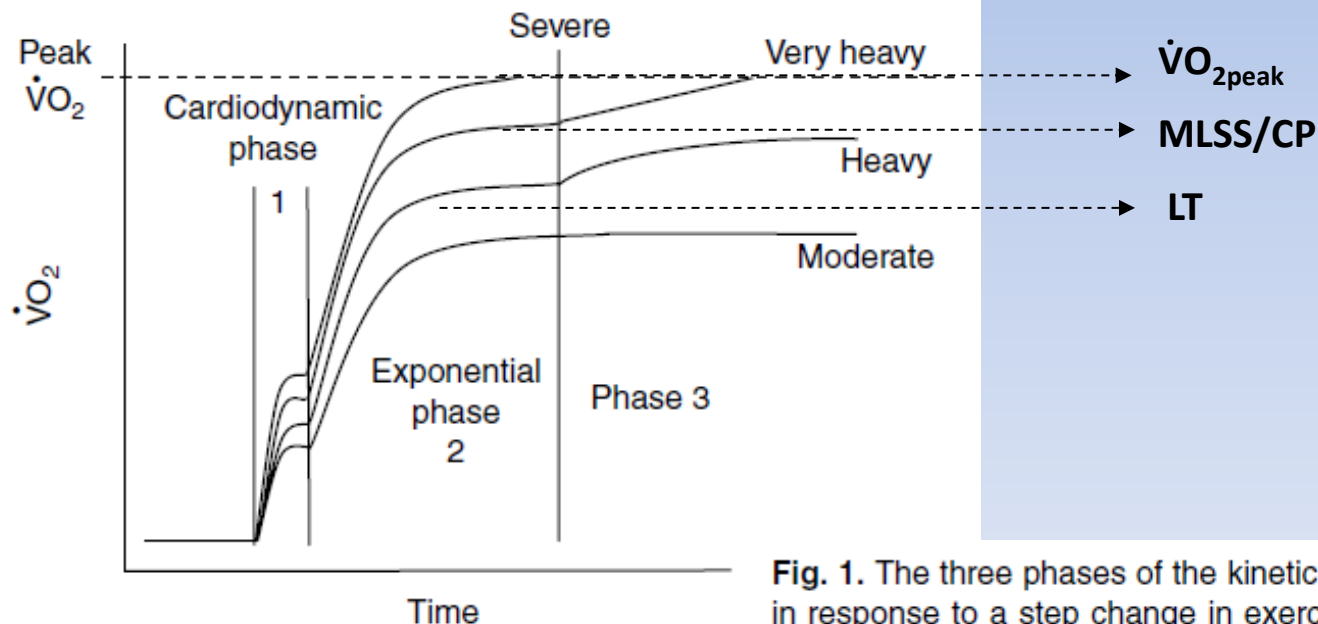
MARK BURNLEY<sup>1</sup> & ANDREW M. JONES<sup>2</sup>

## Three phases of $\dot{V}O_2$



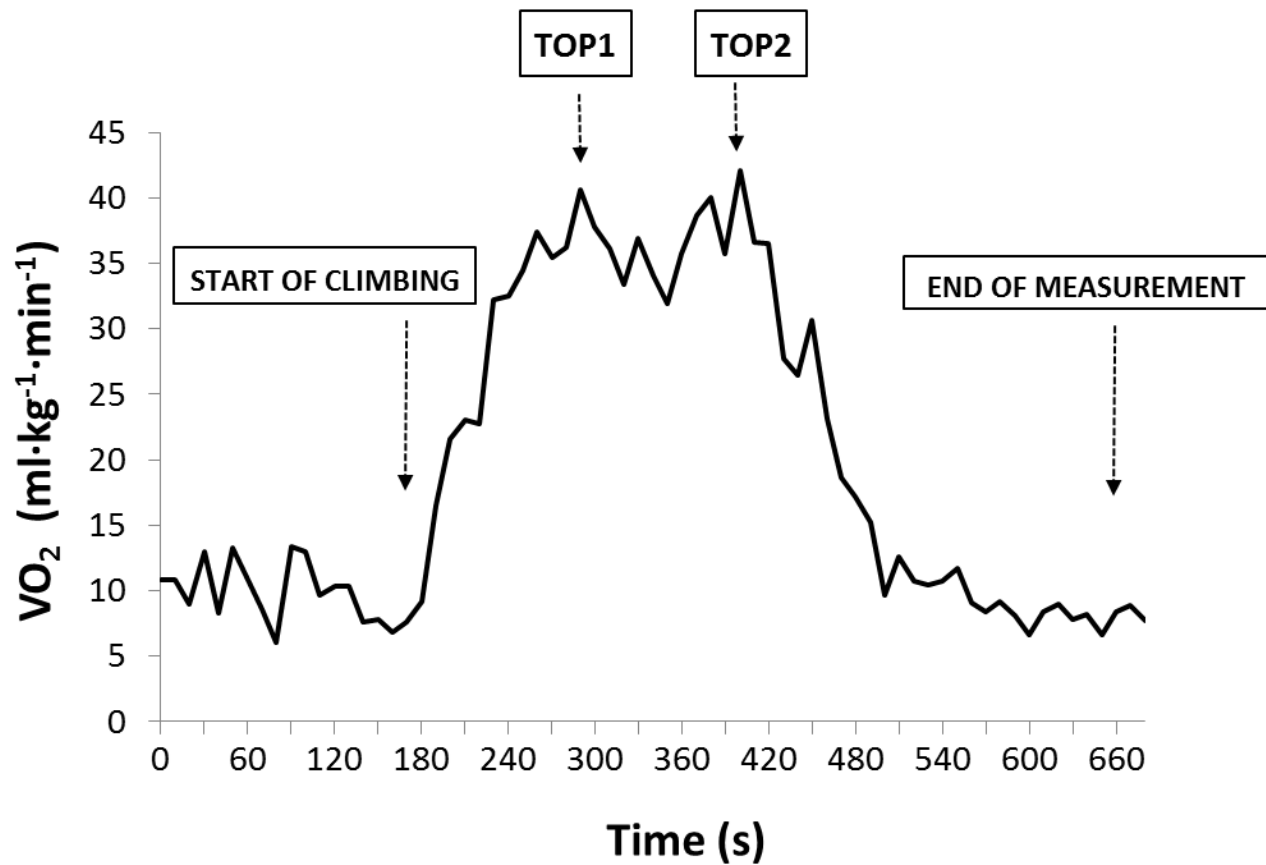
# Oxygen Uptake Kinetic Response to Exercise in Children

Samantha G. Fawkner and Neil Armstrong



**Fig. 1.** The three phases of the kinetic rise in oxygen uptake ( $\dot{V}O_2$ ) in response to a step change in exercise in four different exercise intensity domains.



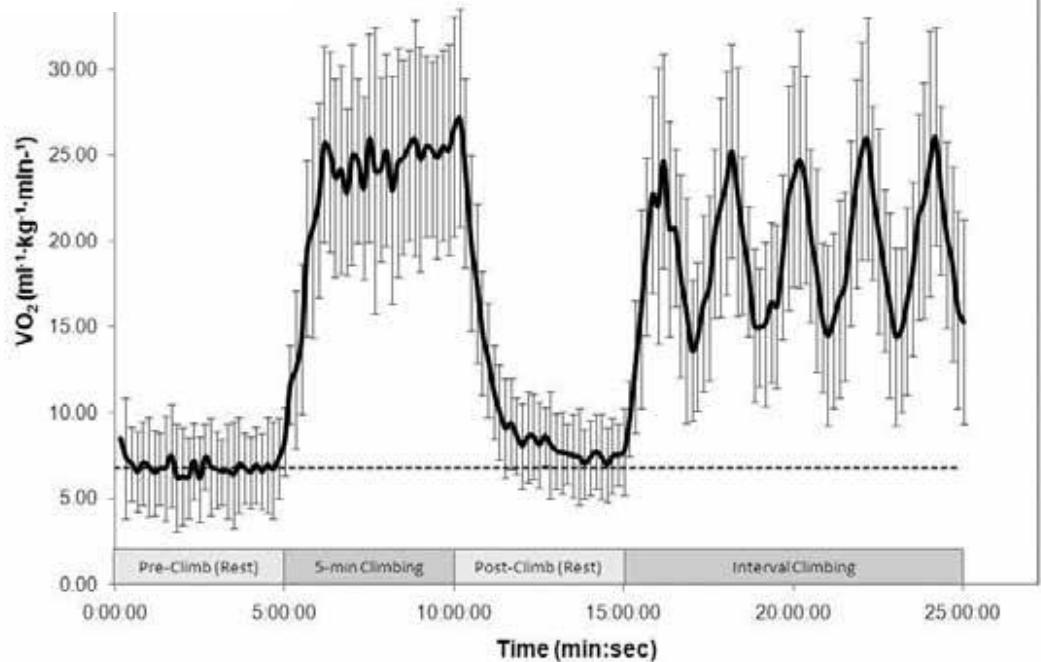


Steady state ?

Slow component ?

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# Climbing metres

- after eight weeks of indoor wall climbing (Baláš & Bunc, 2007; Baláš, et al., 2009)

- grip strength
- upper body muscular endurance
- amount of relative body cellular mass

80 meters per week in beginner and moderately experienced climbers → maintaining or developing upper body strength.



**distance climbed an important factor to assess the effect of climbing**

35 metres per climbing lesson → Can we expect any health benefits from the activity?

# High-intensity-training (HIT)

- climbing → short intermittent bursts with a high intensity
- one sixth of lesson time actually climbing at moderate or vigorous intensity (calculated from meters climbing per 60-minute lesson).
- to improved health outcomes + significantly improve aerobic fitness in children (Baquet et al., 2010; de Araujo et al., 2012).

Children achieved the  $\dot{V}O_{2peak}$  around **40 ml·kg<sup>-1</sup>·min<sup>-1</sup>** → sufficient intensity to support the health of children through climbing?

## PHYSIOLOGICAL ADAPTATION IN NONCOMPETITIVE ROCK CLIMBERS: GOOD FOR AEROBIC FITNESS?

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- rock climbing fulfils sports medicine recommendations for maintaining a good level of aerobic fitness?
- total ascent time should be around 150 minutes per week to match the American College of Sport Medicine (ACSM) → this is the equivalent to approximately 500-700 metres of climbing, per week
- $0.28 - 0.33 \text{ kJ}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$  X our results are significantly higher, by about  $0.46 \text{ kJ}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$

# Conclusion

- sufficient intensity to influence aerobic fitness in children
- High Intensity Interval (HIT) training with longer periods of rest
- it is difficult to estimate an accurate value of energy expenditure for climbing in younger children