Exercise prescription as a novel approach to increase response rates to $\dot{V}O_{2\text{max}}$

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Key points

1. Increases in maximum oxygen uptake, or $\dot{V}O_{2\text{max}}$, (e.g. $\Delta$ 1 MET) are associated with reductions in mortality and morbidity, improvements in endurance performance, etc.

2. Increases in $\dot{V}O_{2\text{max}}$ following training are heterogenous. Some factors affecting response variability may not be controlled, but some factors are modifiable – typically around training characteristics.

3. Method of exercise prescription dictates the acute responses to exercise, and thus may also affect response rates.

4. Endurance training prescribed relative to physiological thresholds may create a more consistent stimuli among individuals, which can affect response rates.
Lower CRF (low \( \dot{\text{VO}_2\text{max}} \), expressed as METs) associated with higher risk of mortality.
Endurance training increases $\dot{V}O_2^{\text{max}}$
2. Heterogeneous response to endurance training

Familial aggregation of $\dot{V}O_2_{\text{max}}$ response to exercise training: results from the HERITAGE Family Study

Claudia Rosalba, Ping An, Tanya Ricks, James S. Skinner, Jack H. Wilmore, Annette Caumo, Louis Fradet, Arthur S. Logan, and D. C. Shaw

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Cell Metabolism

Understanding the variation in exercise responses to guide personalized physical activity prescriptions

John M. Sallis, Jr., Jeffrey J. Wilkins, James P. DiFrance, Louis E. Spangler, and Brian W. Haskell
Biological and methodological factors affecting $V_{O2}\text{max}$ response variability to endurance training and the influence of exercise intensity prescription

Samuel Meyler | Lindsay Bottoms | Daniel Muniz-Punares
Biological and methodological factors affecting $V_{O2\max}$ response variability to endurance training and the influence of exercise intensity prescription

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Refuting the myth of non-response to exercise training: ‘non-responders’ do respond to higher dose of training

David Montero$^1,2$ and Carsten Lundby$^3$

$^1$Swiss Center for Integrative Human Physiology (ZHIPS), Institute of Physiology, University of Zurich, Switzerland
$^2$Department of Cardiology, University Hospital Zurich, Switzerland
Biological and methodological factors affecting VO2max response variability to endurance training and the influence of exercise intensity prescription

Samuel Meyler | Lindsay Bottoms | Daniel Muniz-Pumares

`g) Intensity`

Separate Effects of Intensity and Amount of Exercise on Interindividual Cardiorespiratory Fitness Response

Robert Ross, Ph.D., Louise de Lannoy, MSc; and Paul. J. Stotz, MSc

`'Amount' of exercise - Low Amount (LA) vs High Amount (HA)`

`Intensity of exercise - High Intensity (HI) vs High Intensity (HI)`
30 min at 85% \( \dot{V}O_{2\text{max}} \)
\[ \dot{V}O_{2\text{max}} = 2.91 \text{ L/min; 215 W} \]
3. Methods to prescribe intensity of exercise

### Hypothetical Example of a 6-Zone Training Model

<table>
<thead>
<tr>
<th>Performance</th>
<th>Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 6: Short Sprint RPE 19-20/20</td>
<td>(Extreme)&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
<tr>
<td>Zone 5: Hand / Interval RPE 17-18/20</td>
<td>CPECS, LT2, LT1, MT2</td>
</tr>
<tr>
<td>Zone 4: Tempo / Threshold RPE 14-16/20</td>
<td>LT1, G2Y</td>
</tr>
<tr>
<td>Zone 3: Steady RPE 12-14/20</td>
<td>3 METs, 5/10 RPE</td>
</tr>
<tr>
<td>Zone 2: Base / Endurance RPE 10-12/20</td>
<td>Light</td>
</tr>
<tr>
<td>Zone 1: Easy RPE 08/20</td>
<td>1.5 METs</td>
</tr>
</tbody>
</table>

### Common Intensity Classifications For Aerobic Physical Activity<sup>4</sup>

- **Light**: 57-63% HRR, 37-45% VO₂max<sub>peak</sub>, 9-11/20 RPE
- **Moderate**: 64-76% HRR, 46-63% VO₂max<sub>peak</sub>, 12-13/20 RPE
- **Vigorous**: 77-95% HRR, 60-89% VO₂max<sub>peak</sub>, 31/10-20 RPE

### Example of Intensity Classifications for Cardiorespiratory Exercise<sup>6</sup>

- **Very Light**: <57% HRR, <37% VO₂max<sub>peak</sub>, 0/20 RPE
- **Light**: 57-63% HRR, 37-45% VO₂max<sub>peak</sub>, 9-11/20 RPE
- **Moderate**: 64-76% HRR, 46-63% VO₂max<sub>peak</sub>, 12-13/20 RPE
- **Vigorous**: 77-95% HRR, 60-89% VO₂max<sub>peak</sub>, 31/10-20 RPE

### Performance vs. Health

- **Severe**: High-intensity exercise
- **Heavy**: Moderate-intensity exercise
- **Moderate**: Low-intensity exercise

### VO₂ (mL·kg⁻¹·min⁻¹) vs. Time (min)

- **VO₂**: Oxygen uptake
- **RPE**: Rate of Perceived Exertion

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**Original Article**: Power-duration relationship: Physiology, fatigue, and the limits of human performance

**Mark Burnley** & **Andrew M. Jones**
Acute responses to exercise are affected by the method of exercise prescription.
Critical power represents a physiological threshold, whereby metabolic, neuromuscular, hemodynamic responses to exercise differ < vs > CP.
If training is prescribed using methods which elicit a homogeneous homeostatic perturbation…

…there is potential for more homogeneous chronic adaptations?
4. ‘Individualised’ exercise prescription

Relatively few studies have compared response rates following TRADITIONAL vs THRESHOLD methods of exercise prescription.

Incidence of VO2max Responders to Personalized versus Standardized Exercise Prescription

RAN M. WEATHERHAN1,2, NIGEL K. HARRIS1, ANDREW E. KILDING2, and LANCE C. DALLECK2

Heavy-, Severe-, and Extreme-, but Not Moderate- Intensity Exercise Increase Vo2max and PWC150 Scores after 6 wk of Training

Etn Calabre Inglis 1, Daniilo Iannetta 1, Letizia Rosca 1, Mary Z Mackie 3, Dan Martin 3, Mackenzie 1, Juan M Murias 1

Individual cardiovascular responsiveness to work-matched exercise within the moderate- and severe-intensity domains

Matsunaga1,2,3 - Philipp Schellhorn4 - Gunner Eyr1 - Christof Burghardt1 - Manuel Widmalm1,2 - Sergio Barbero4 - Rogerio N. Soares1, Juan M. Murias1,3 - Angar Thiel1,3 - Andreas M. Niel1,2

Is a threshold-based model a superior method to the relative percent concept for establishing individual exercise intensity? a randomized controlled trial

Allan E. Wolters1, Dana J. Burgan1, Jeffrey M. Jones1 and Lance C. Daleck1
Meta-analysis of IPD

Healthy, non-obese (BMI < 30 kg·m²) adults undertaking endurance training for > 3 wks, endurance training only (no concurrent training, no additional intervention), direct measurement of $\bar{V}O_{2\text{max}}$.

- 4 studies (139 Participants) from studies comparing TRAD vs THR vs CON group.
- 43 studies (1544 participants) from studies reporting TRAD or THR.

<table>
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<tbody>
<tr>
<td>Changes in cardiorespiratory fitness following exercise training prescribed relative to traditional</td>
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<tr>
<td>intensity anchors and to physiological thresholds: a systematic review with meta-analysis of individual participant data</td>
</tr>
<tr>
<td>Running heading</td>
</tr>
<tr>
<td>Cardiorespiratory Fitness and Exercise Intensity Prescription: Individual Participant Data Meta-analysis</td>
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AUTHORS

Samuel J. R. Meyer1, Paul A. Swainston1, Lindsey Bottoms1, Lance C. Dalleck2, Ben Hunter1, Mark A. Sarzynski2, David Wellsted1, Camilla J. Williams1, Daniel Muniz-Pumares1
Results from this IPD MA suggest exercise prescribed relative to physiological thresholds increases response rates by increasing the mean response…

whilst having negligible effect on response variability.
Few final considerations

- Studies have different methodologies, and therefore comparison between studies is difficult. Few studies have directly compared THR-based vs TRAD-based approaches.
- Effects on variability may be difficult to detect. Large sample sizes required ($$$).
- Looking for alternatives, e.g. repeating measurements ($).
1. Increases in maximum oxygen uptake, or \( \dot{V}O_{2\text{max}} \), (e.g. \( \Delta 1 \text{ MET} \)) are associated with reductions in mortality and morbidity, improvements in endurance performance, etc.

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