

High Intensity Interval Training to Enhance Performance

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Disclosures



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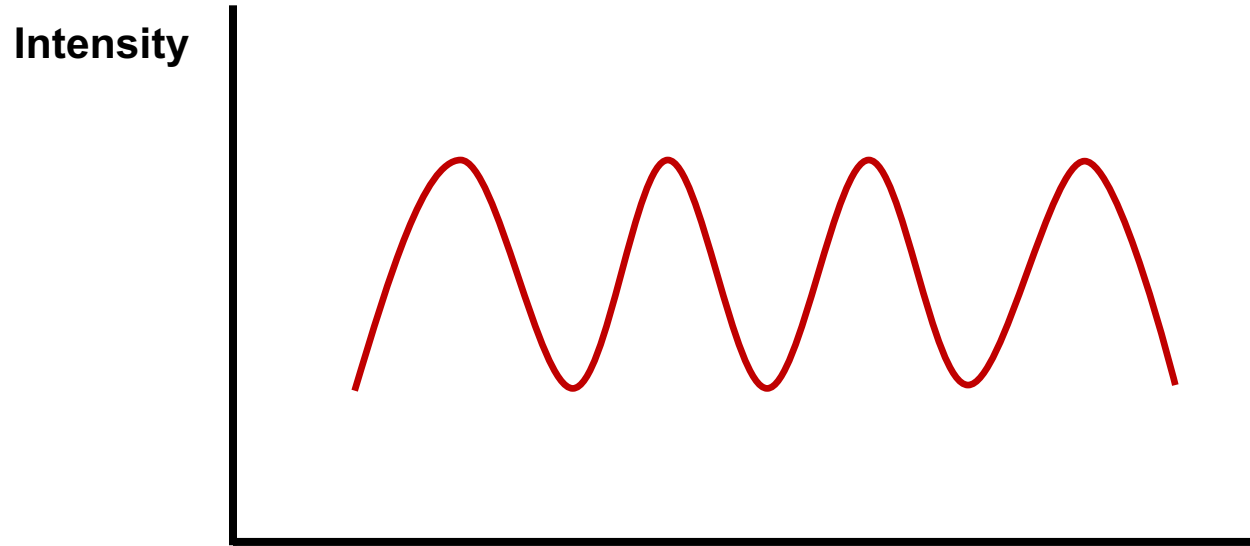
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Learning Objectives

- 1) **To explain the physiological basis of interval training for endurance performance enhancement.**
- 2) **To interpret evidence regarding the effect of various interval training strategies on endurance performance.**

What Is (High-Intensity) Interval Training?

Intermittent bouts of relatively hard effort and recovery periods



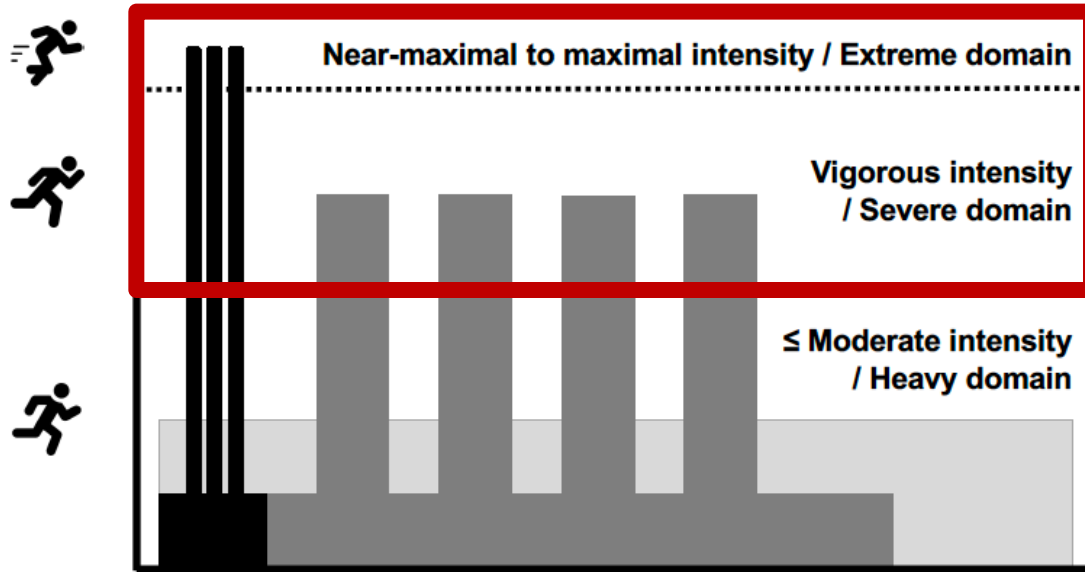
How to Classify Training Intensity?

Performance

Health



How to Classify Training Intensity?





What is Best Practice for Training Intensity and Duration Distribution in Endurance Athletes?

Stephen Seiler

International Journal of Sports Physiology and Performance, 2010, 5, 276-291

“HIT (high-intensity interval training) is a critical component in the training of all successful endurance athletes...

an approximate 80-to-20 ratio of LIT to (threshold)/HIT... gives excellent long-term results among endurance athletes.”

Improved athletic performance in highly trained cyclists after interval training

6 HIIT sessions (6-8 x 5 min @ 80% PPO) over 4 wk in male cyclists (n=12)

“a 4-wk program of HIT increased the PPO and fatigue resistance of competitive cyclists and improved their 40-km time-trial performance...”

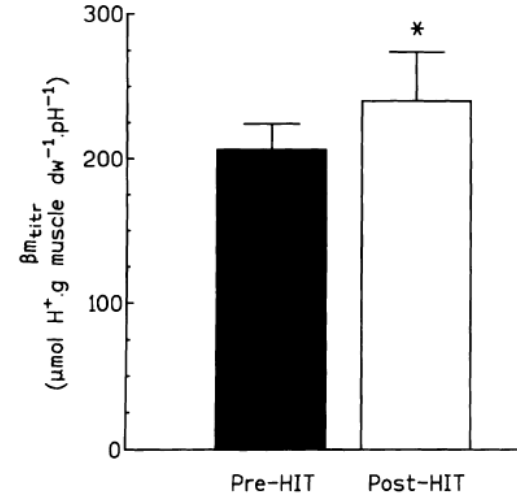
The extent to which physiological versus psychological factors may be responsible for the improvement in performance is not easily determined.”

Skeletal muscle buffering capacity and endurance performance after high-intensity interval training by well-trained cyclists

6 HIIT sessions (6-8 x 5 min @ 80% PPO) over 4 wk in male cyclists (n=6)

	\dot{W}_{peak} (W)	t_{T40} (min)	t_{F150} (s)
Pre-HIT	417.5 (48.8)	57.1 (4.4)	59.3 (9.0)
Post-HIT	432.3 (46.3)	55.9 (4.2)	72.5 (10.8)
	$P < 0.05$	$P < 0.05$	$P < 0.05$

	CS	3-HAD	PFK	HK
Pre-HIT	162 (23)	86 (7)	304 (39)	14.9 (4.2)
Post-HIT	166 (23)	88 (8)	344 (64)	16.6 (2.5)
	ns	ns	ns	ns



Skeletal muscle buffering capacity and endurance performance after high-intensity interval training by well-trained cyclists

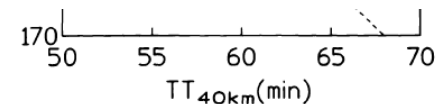
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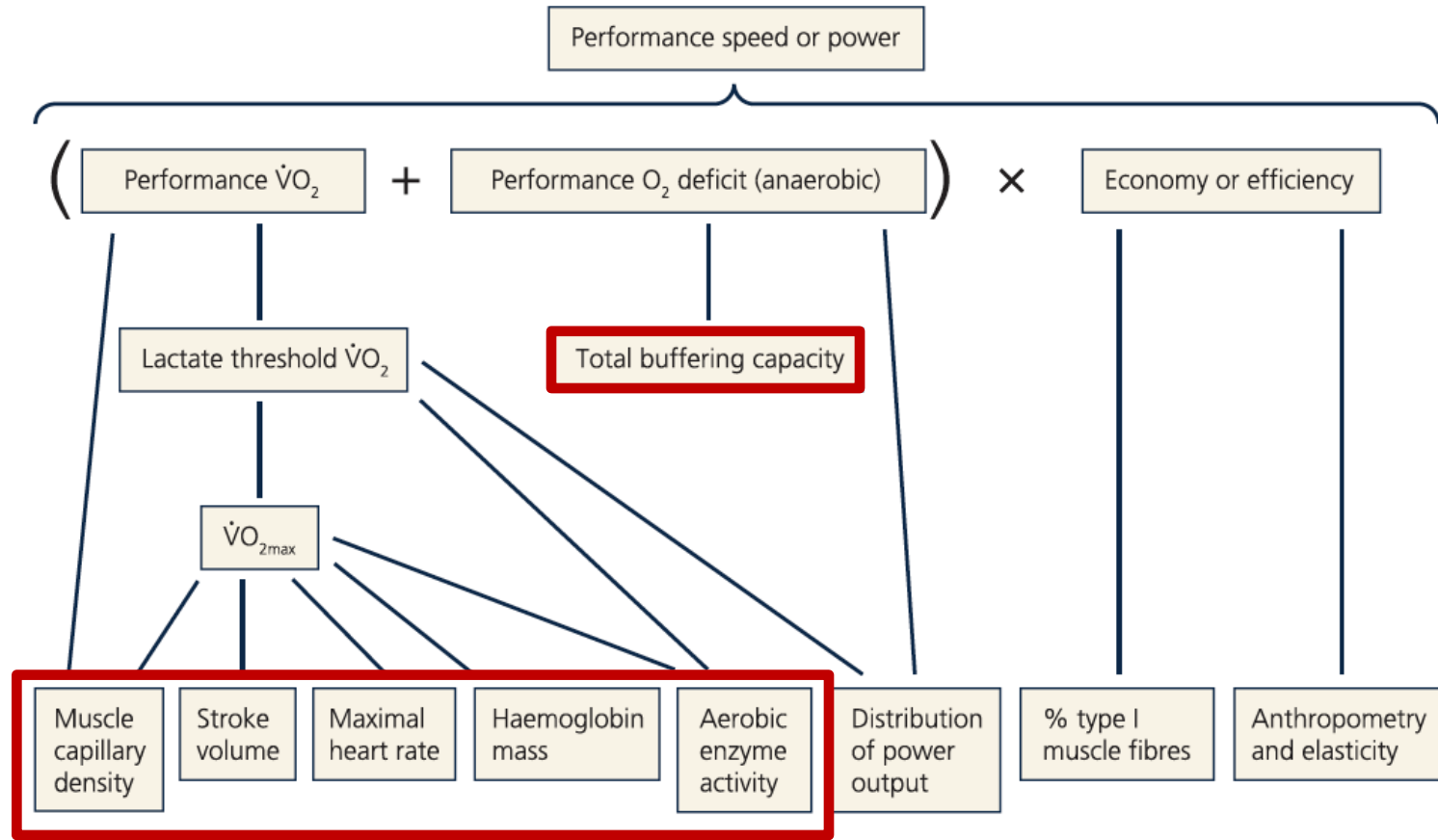
\dot{W}_{peak} (W) t_{T40} (min) t_{F150} (s)

Relationship between 40 km time trial & $\beta_{m_{titr}}$

“Oxidative muscle enzyme activities were not altered by the HIT regime (but) Bm was sensitive to sustained submaximal HIT in already well-trained cyclists and emerged as a significant predictor of high-intensity endurance performance.”

Post-HIT	166 (23)	88 (8)	344 (64)	16.6 (2.5)
	ns	ns	ns	ns

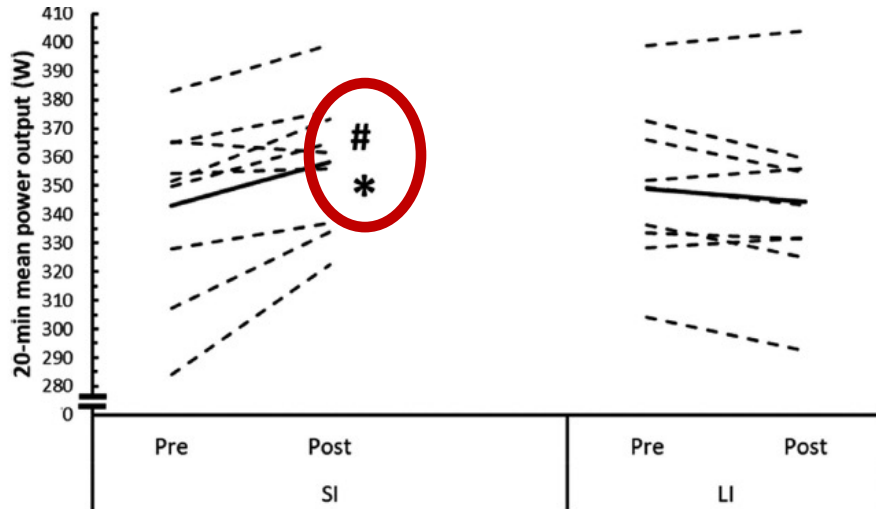




Superior performance improvements in elite cyclists following short-interval vs effort-matched long-interval training

9 sessions over 3-wk of ~20 min of work intervals at *maximal sustainable effort* (n=18)

“short” = 3 series of 9 x 30-s (15-s recovery) or “long” = 4 x 5 min (2.5 min recovery)



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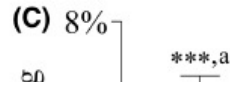
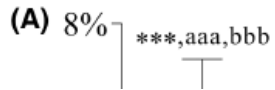
“short” = 3 series of 9 x 30-s (15-s recovery) or “long” = 4 x 5 min (2.5 min recovery)

“SI induces superior training adaptations on endurance and performance parameters compared with LI in elite cyclists (despite) similar effort ...

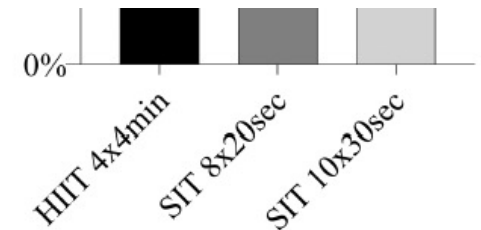
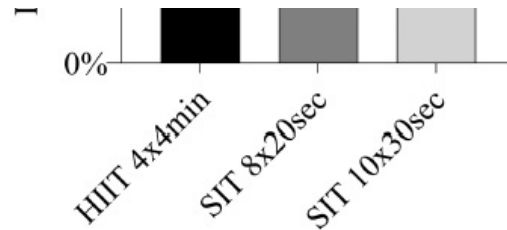
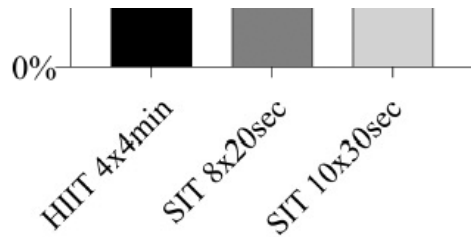
The findings would be strengthened if reproduced after a longer training intervention (and) approaches to investigate the underlying mechanisms.”

Aerobic high-intensity intervals are superior to improve $\dot{V}O_{2max}$ compared with sprint intervals in well-trained men

48 men (~63 ml/kg/min) performed 24 sessions over 8 wk of HIIT (4 x 4-min @ 95% MAS) or one of two SIT protocols (8-10 x 20-30 s @ 150-175% of MAS)



“HIIT 4 x 4 min is superior for increasing $\dot{V}O_{2max}$ compared with SIT protocols (and) should be the recommended interval format for aerobic performance.”



Aerobic high-intensity intervals improve $\dot{V}O_{2\max}$ more than supramaximal sprint intervals in females, similar to males

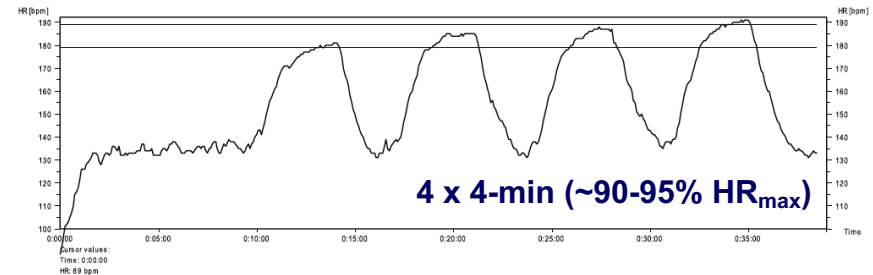
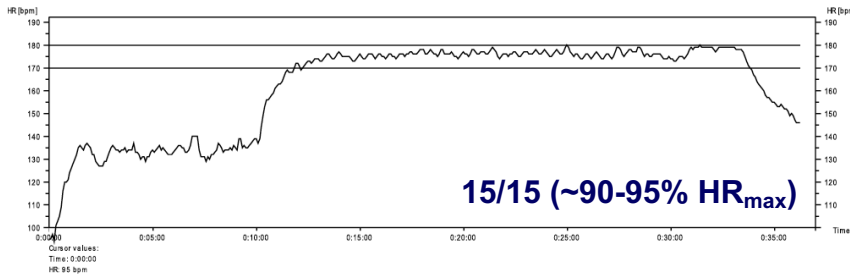
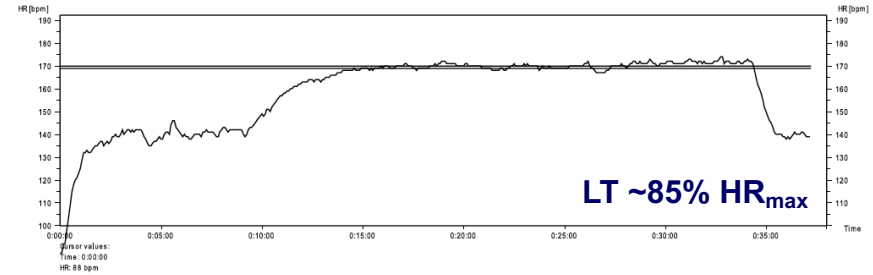
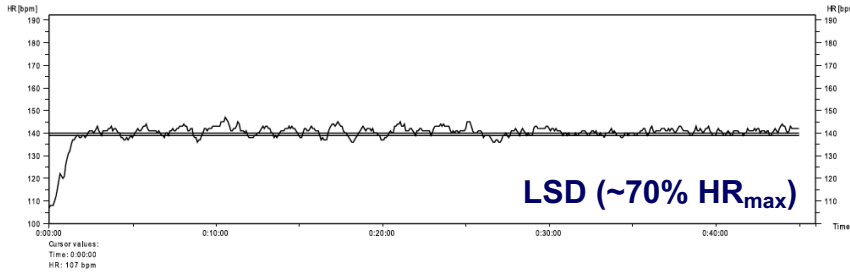
81 females (~52 ml/kg/min) performed 24 sessions over 8 wk of HIIT (4 x 4-min @ 95% MAS) or one of two SIT protocols (8-10 x 20-30 s @ 150-175% of MAS)

“HIIT improved $\dot{V}O_{2\max}$ more than SIT (and was) equally effective in females and males of similar training status...

SIT induced an unacceptable rate of muscular strains (and) all-out treadmill running (is) potentially more harmful.”

Aerobic High-Intensity Intervals Improve $\dot{V}O_{2max}$ More Than Moderate Training

40 trained men (~55-60 ml/kg/min) performed matched work training 3x/wk for 8 wk



Aerobic High-Intensity Intervals Improve $\dot{V}O_{2\max}$ More Than Moderate Training

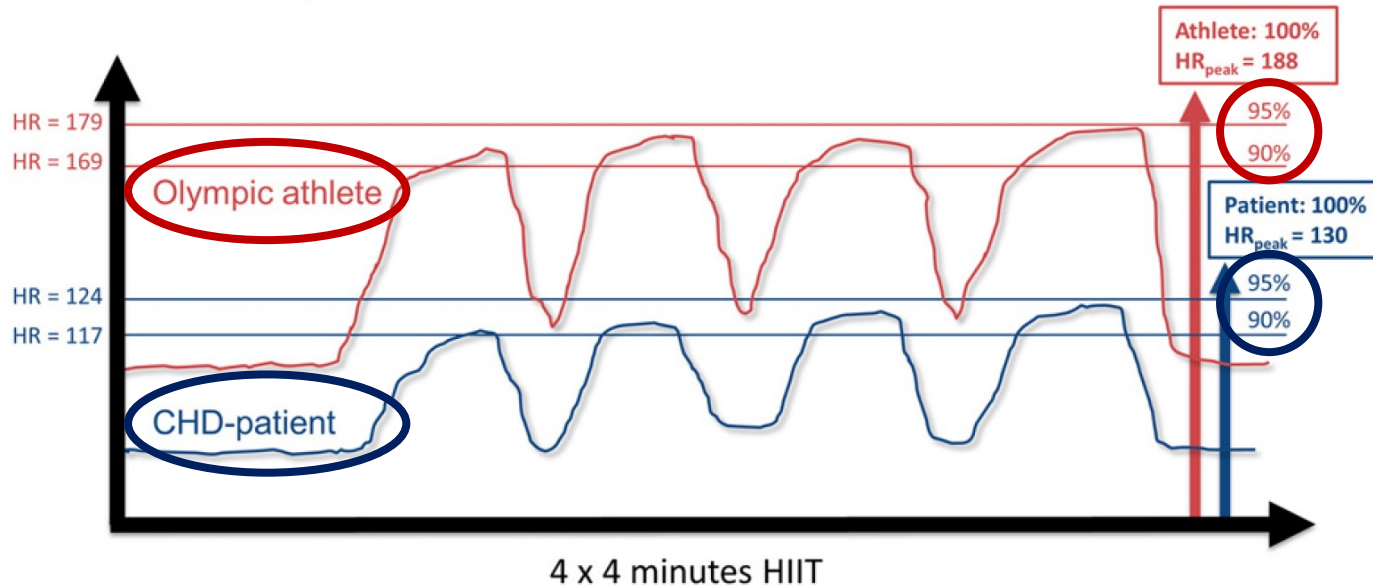
40 trained men (~55-60 ml/kg/min) performed matched work training 3x/wk for 8 wk



“When total work and training frequency are matched, higher aerobic intensity leads to larger improvements in $\dot{V}O_{2\max}$ (which) seem to be a function of increased SV resulting in increased Q.”

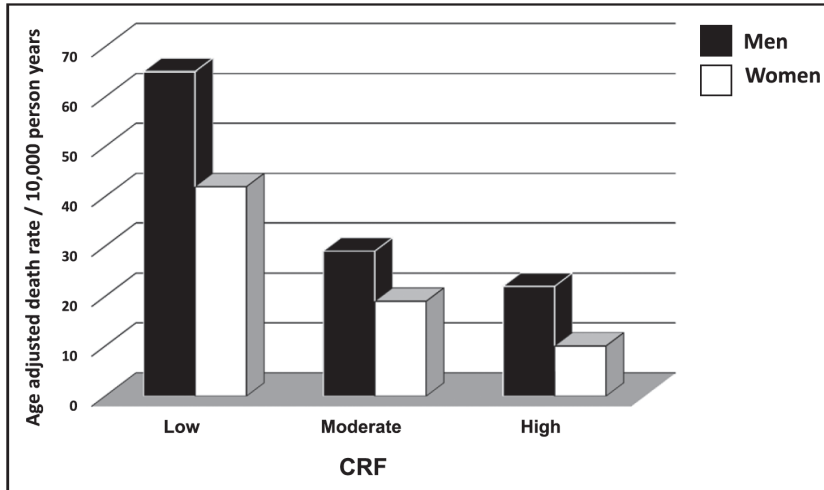


HIIT is Highly Scalable And Not Only for Athletes



Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign

A Scientific Statement From the American Heart Association



Meta-analysis of >100,000 people:

1-MET ↑ CRF = 13% ↓ mortality

Risk reduction comparable to:

- **7-cm ↓ in waist circumference**
- **5-mm Hg ↓ in systolic BP**
- **1 mmol in ↓ plasma glucose**

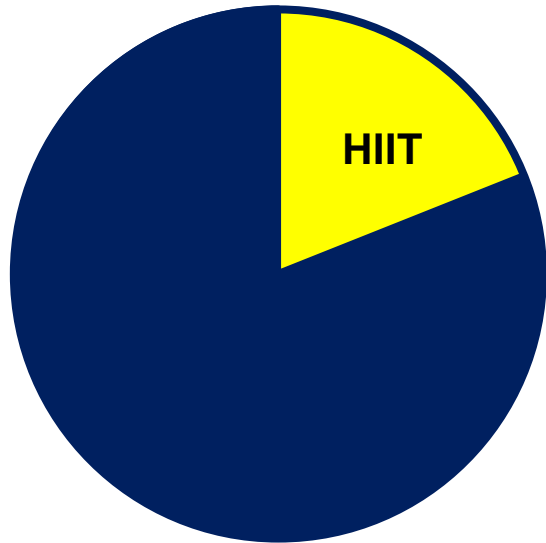
A systematic review and cluster analysis approach of 103 studies of high-intensity interval training on cardiorespiratory fitness



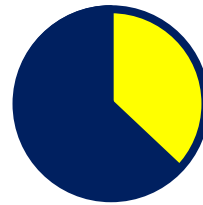
“All three HIIT modalities produced significant improvements of CRF, although some modalities showed greater changes for (some) indicators.”

Is The Appropriate Intensity Mix Dependent on Volume?

And does this depend on the training goal(s) i.e. performance vs health?



~30 h/wk (~80:20)



~3 h/wk?



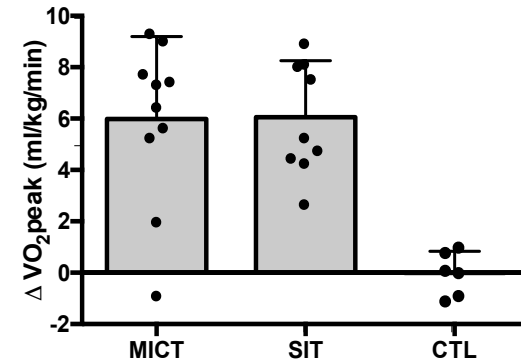
~30 min/wk?

Twelve Weeks of Sprint Interval Training Improves Indices of Cardiometabolic Health Similar to Traditional Endurance Training despite a Five-Fold Lower Exercise Volume and Time Commitment

12 wk of training (3x/wk) of SIT, MICT or non-exercise control in sedentary men

	SIT	MICT
Protocol	3 x 20-s 'all out' sprints over 10 min	50 min continuous moderate intensity
Mean HR	79±4%	71±5%
RPE /20	16±1 (hard)	13±1 (somewhat hard)

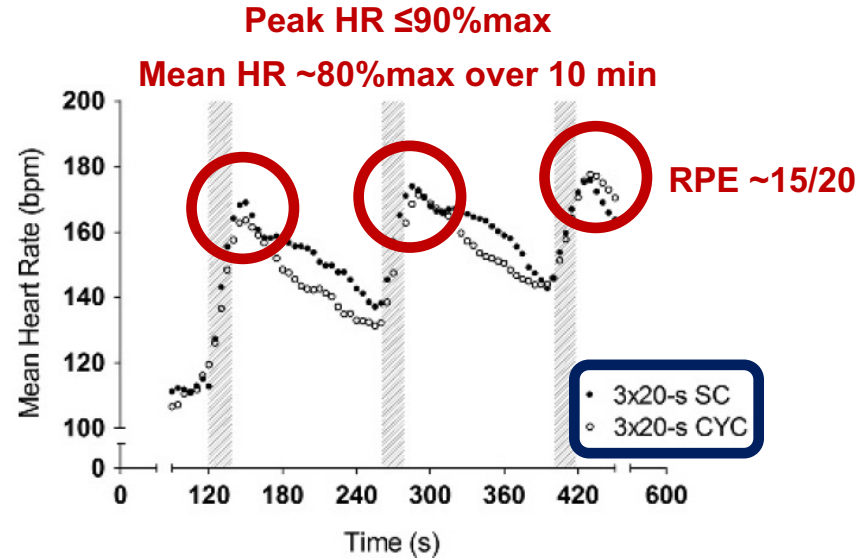
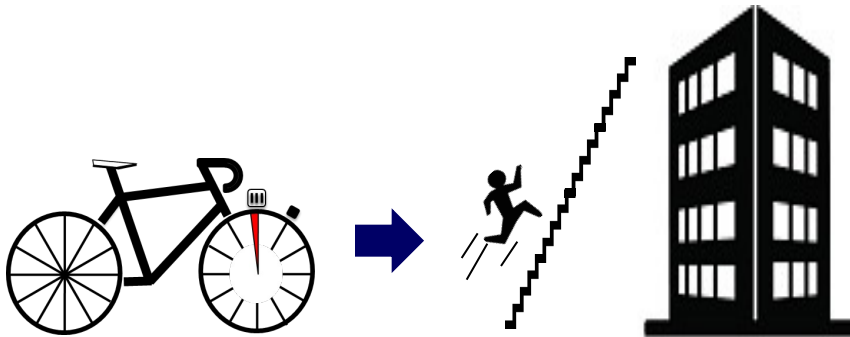
CRF ↑ 19% (~ 2 METs)



Brief Intense Stair Climbing Improves Cardiorespiratory Fitness

3 x 20-s efforts over 10 min, 3x/wk for 6 wk (n=8-12)

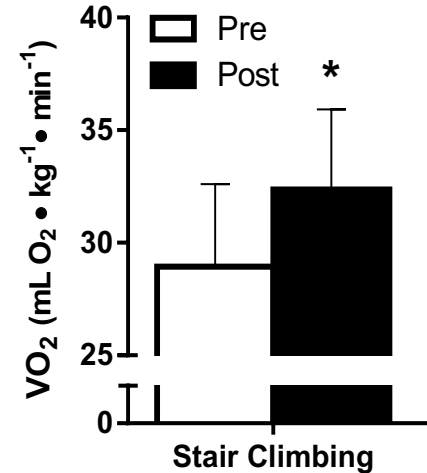
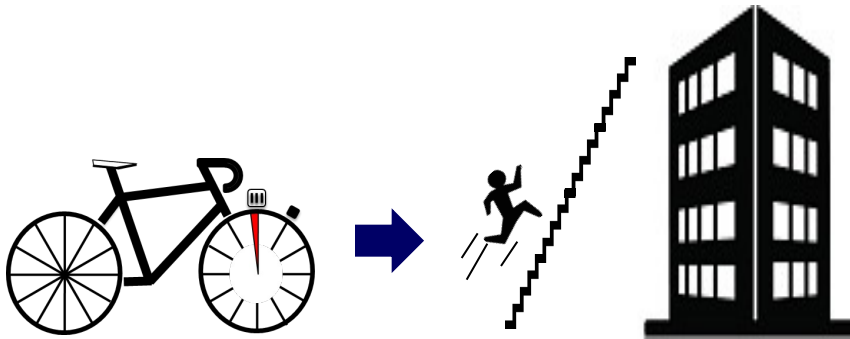
“Climb the stairs as quickly and safely as possible, taking one step at a time.”



Brief Intense Stair Climbing Improves Cardiorespiratory Fitness

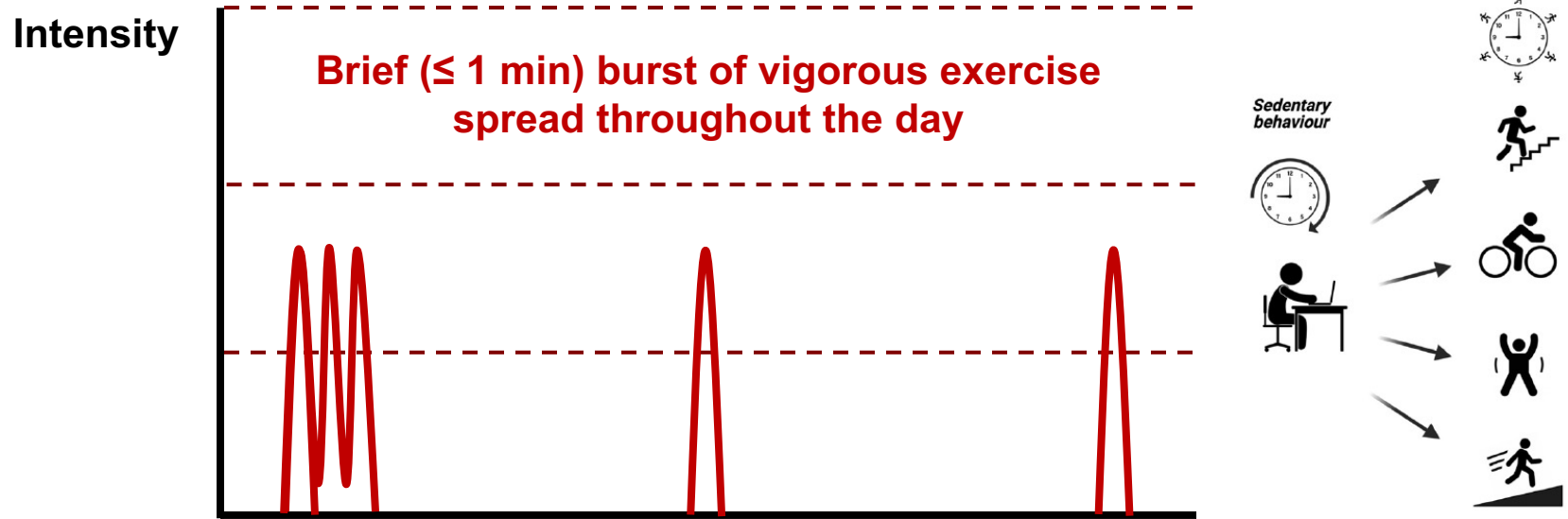
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Exercise Snacks: A Novel Strategy to Improve Cardiometabolic Health

Hashim Islam¹, Martin J. Gibala², and Jonathan P. Little¹

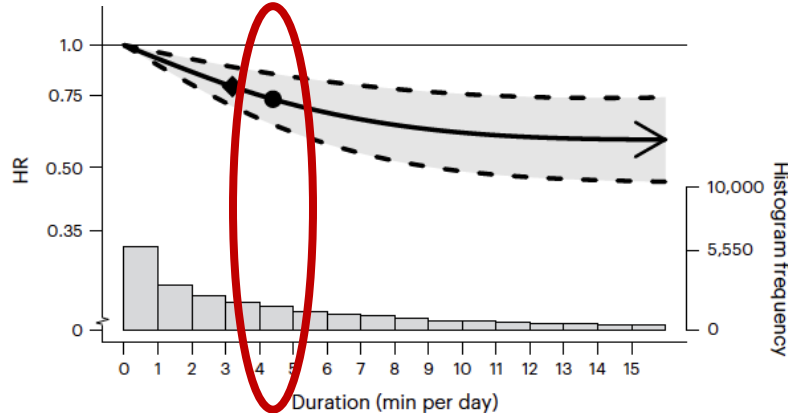


Association of wearable device-measured vigorous intermittent lifestyle physical activity with mortality

Emmanuel Stamatakis¹✉, Matthew N. Ahmadi¹, Jason M. R. Gill²,
Cecilie Thøgersen-Ntoumani³, Martin J. Gibala⁴, Aiden Doherty⁵ &
Mark Hamer⁶



VILPA = Brief ($\leq 1-2$ min) bouts of vigorous activity spread throughout the day
>25,000 'nonexercisers' in the UK Biobank over a follow-up of ~7 years



“The median daily VILPA duration of 4.4 min per day was associated with a 26%-30% reduction in all-cause and cancer mortality and a 32%-34% reduction in CVD mortality risk.”

Take Home Points

- 1) **High-intensity interval training is a critical element to enhance performance in high-level endurance athletes.**
- 2) **The specific intensity distribution and training prescription to optimize responses is unclear (and depends on many factors).**
- 3) **Brief vigorous intermittent activity is a time-efficient strategy to improve functional capacity and health in less-trained individuals.**



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