

# TRENO INTERVALADO DE ALTA INTENSIDADE (HIT) E TRENO DE *SPRINTS* INTERVALADOS (SI): QUAIS SÃO OS EFEITOS E APLICABILIDADE NA CANOAGEM

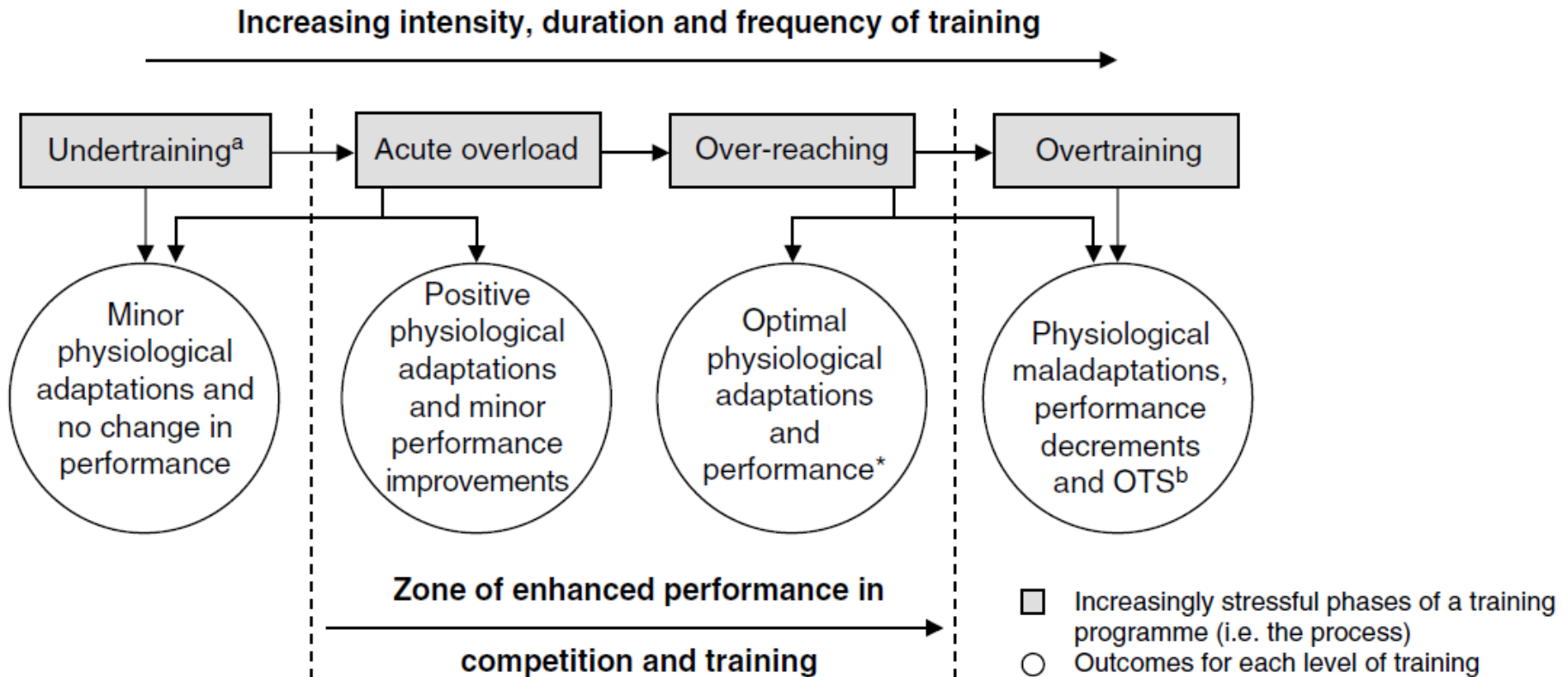
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Prof. Dr. Fábio Yuzo Nakamura



# O continuum do sobretreinamento

Armstrong & VanHeest (2002)



# Functional Overreaching: The Key to Peak Performance during the Taper?

ANAËL AUBRY<sup>1</sup>, CHRISTOPHE HAUSSWIRTH<sup>1</sup>, JULIEN LOUIS<sup>1</sup>, AARON J. COUTTS<sup>2</sup>, and YANN LE MEUR<sup>1</sup>

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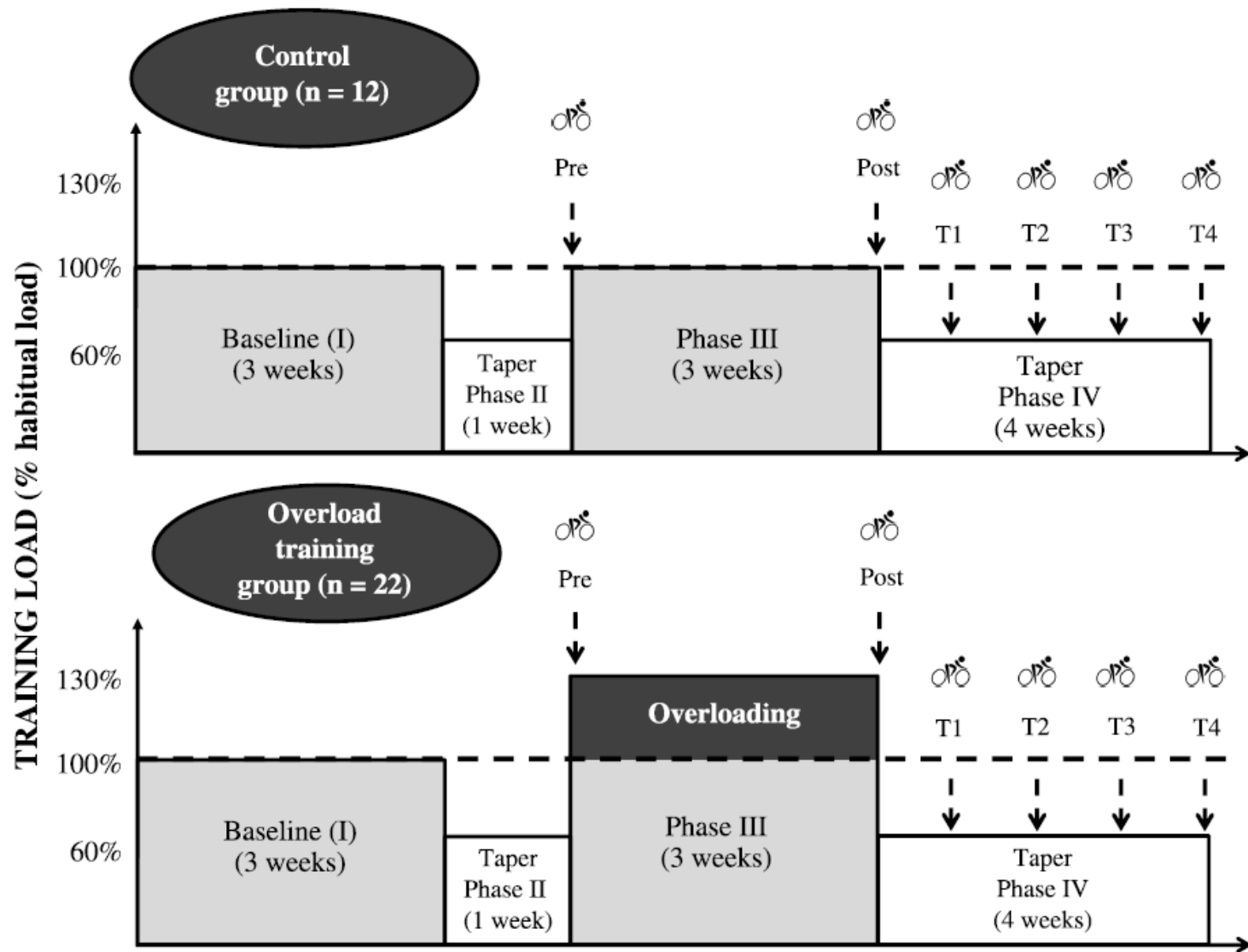
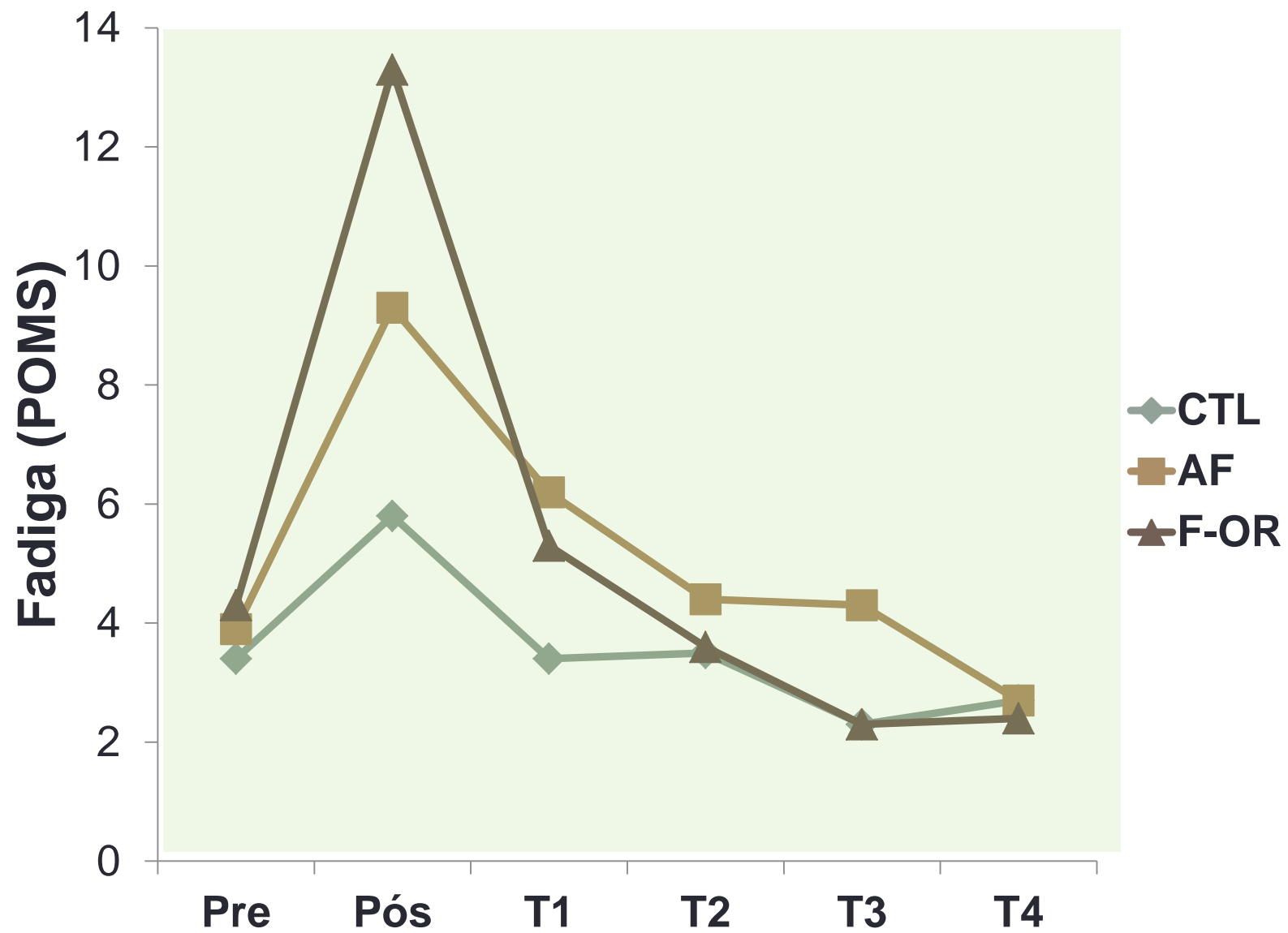
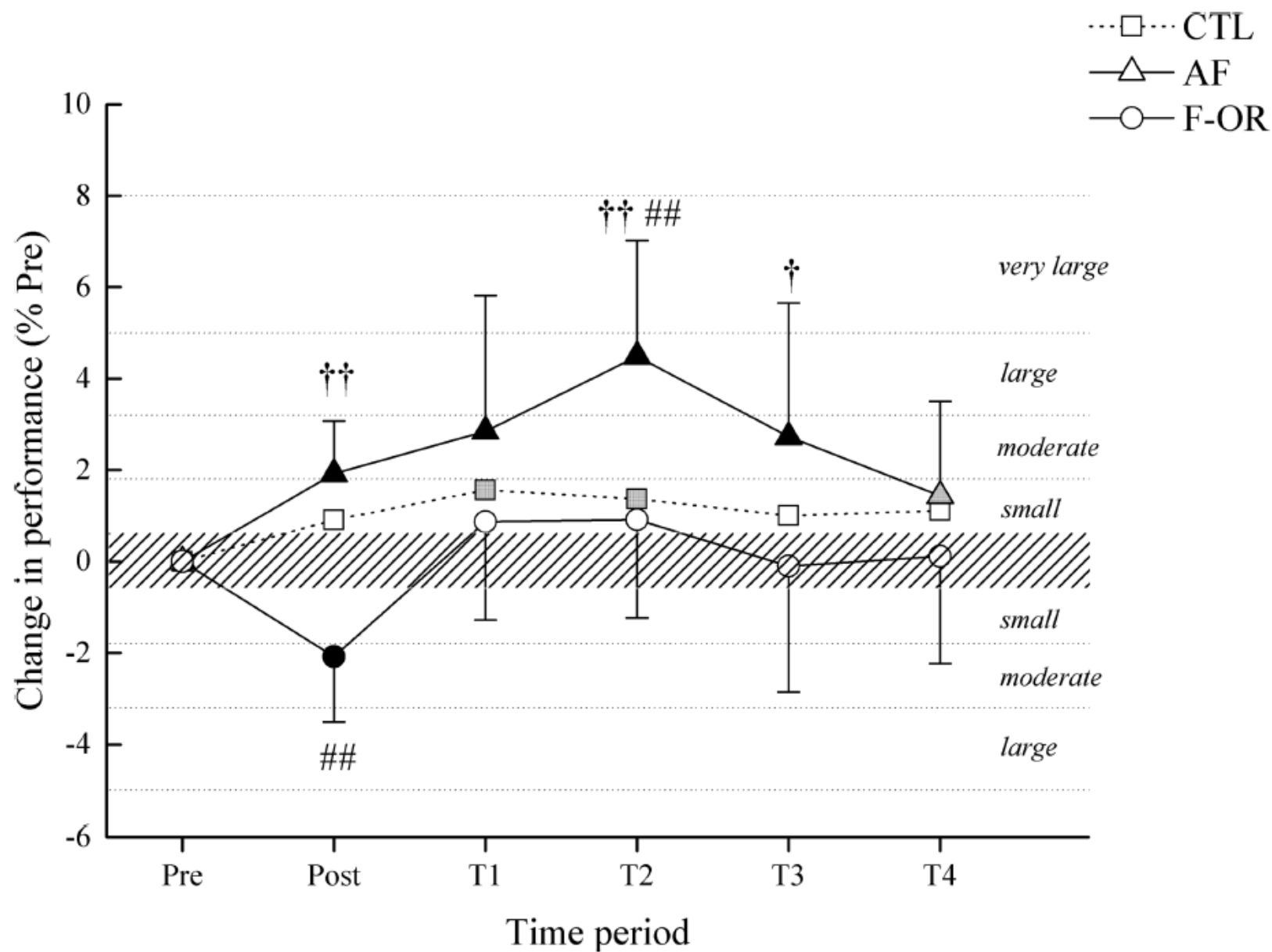


FIGURE 1—Schematic representation of the experimental protocol. Bicycle symbols represent maximal incremental cycling tests. During phase IV, the subjects performed a test at the end of each week (T1, T2, T3, and T4).





F. M. Impellizzeri<sup>1</sup>

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## Physiological and Performance Effects of Generic versus Specific Aerobic Training in Soccer Players

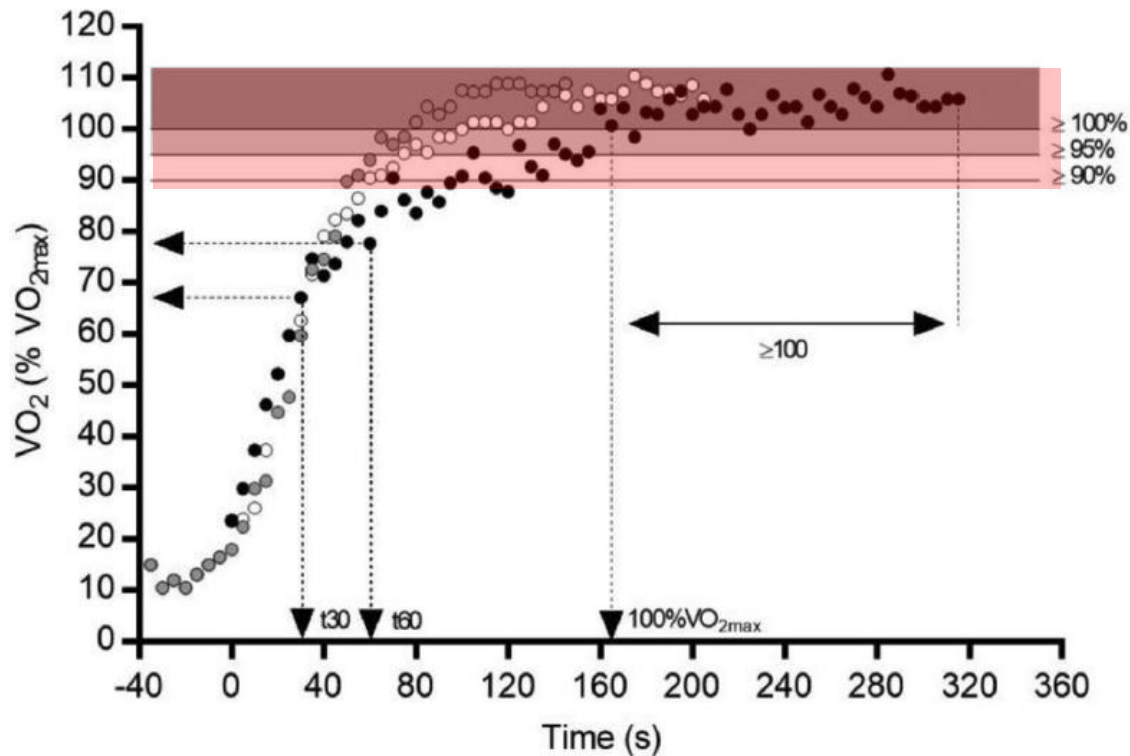
**4 × 4 min (3 min rec) a 90–95% da  $\dot{V}O_{2\max}$**



## Aerobic endurance training improves soccer performance

JAN HELGERUD, LARS CHRISTIAN ENGEN, ULRIK WISLØFF, and JAN HOFF

# Red Zone

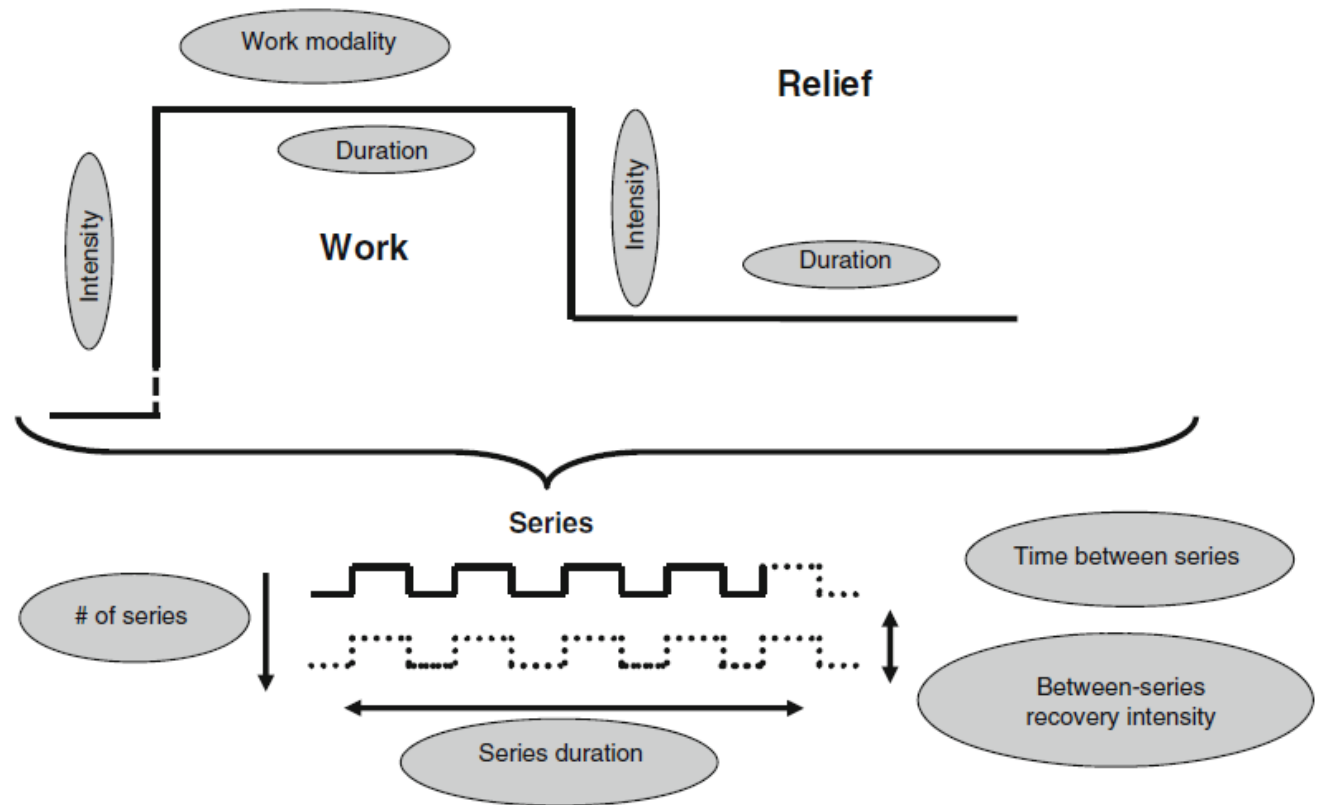


**Figure 1** — Percentage of  $\text{VO}_2$  relative to  $\text{VO}_{2\text{max}}$  of 1 subject performing the square-wave transition exercises at 105% (gray), 100% (white), and 95% (black) of  $v\text{VO}_{2\text{max}}$  intensities, with the 90%, 95%, and 100% of  $\text{VO}_{2\text{max}}$  intensities, and 100%  $\text{VO}_{2\text{max}}$ ,  $\geq 100$ ,  $t_{30}$  (30-s time period), and  $t_{60}$  (60-s time period) temporal parameters identified for the 95% of  $v\text{VO}_{2\text{max}}$  intensity.

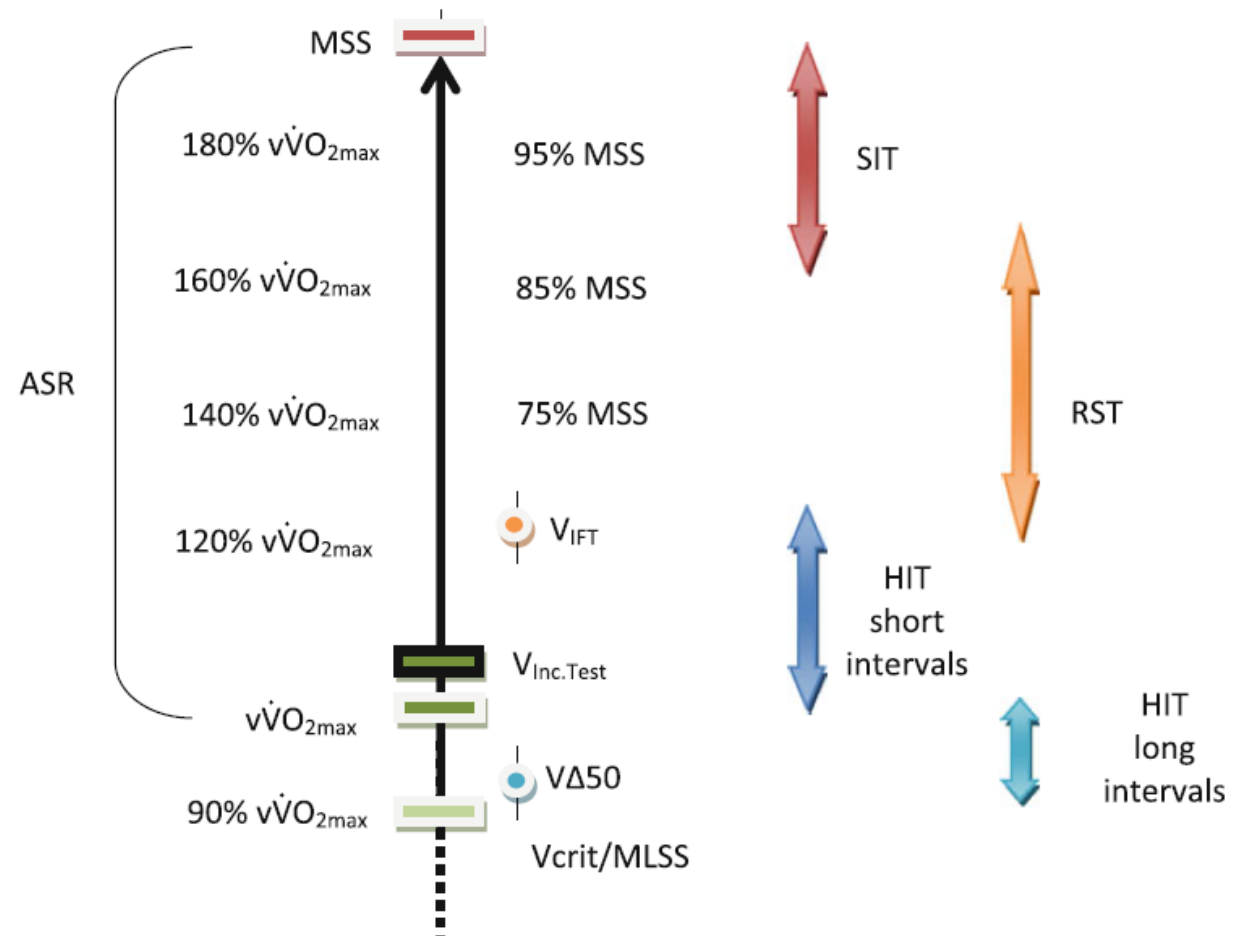
Sousa, A., Vilas-Boas, J. P., Fernandes, R. J., & Figueiredo, P. (2017).  $\text{VO}_2$  at maximal and supramaximal intensities: lessons to high-intensity interval training in swimming. *International journal of sports physiology and performance*, 12(7), 872-877.



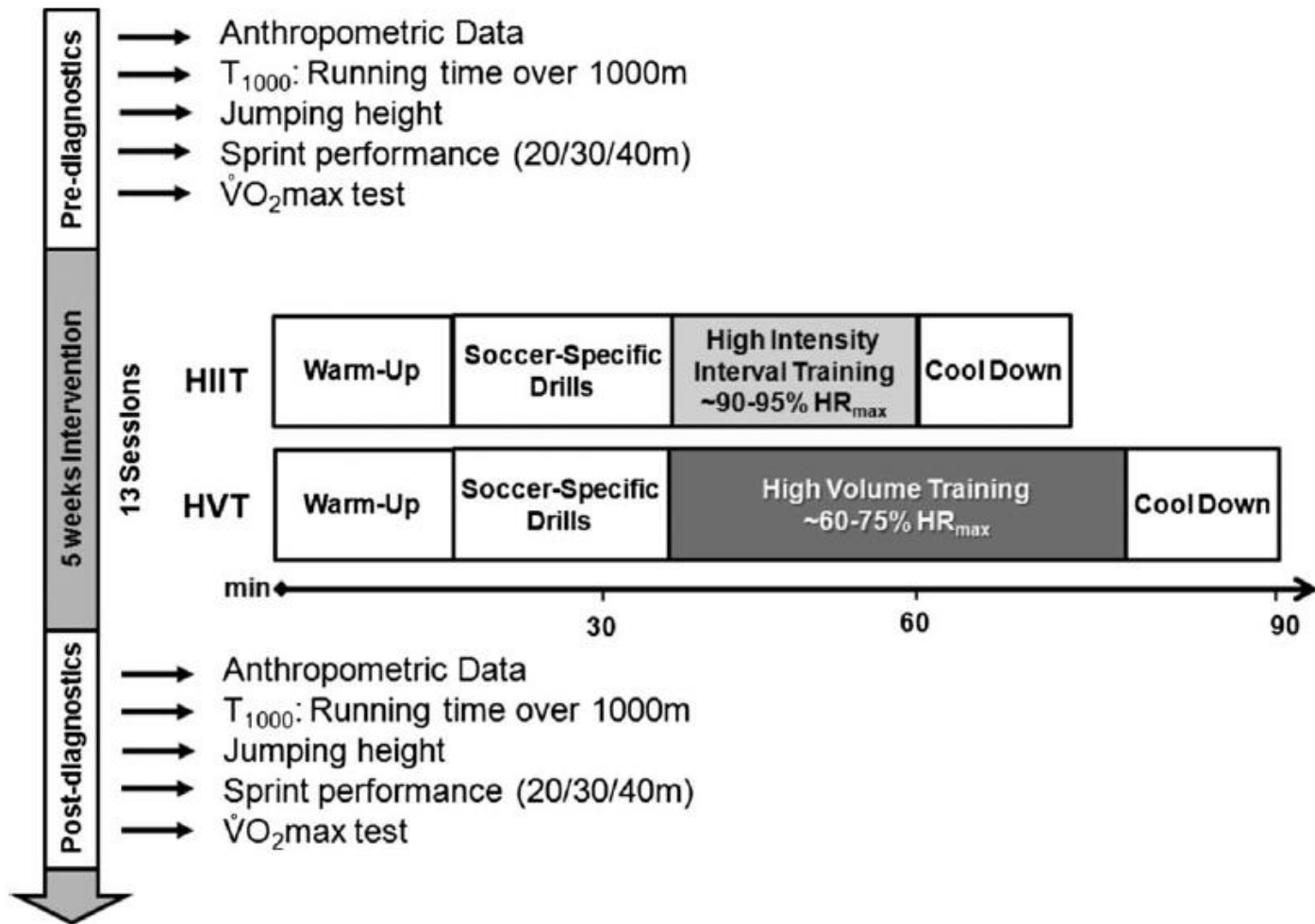
**Fig. 2** Schematic illustration of the nine variables defining a HIT session adapted from Buchheit [35]. *HIT* high-intensity interval training



**Fig. 3** Intensity range used for the various run-based HIT formats. *ASR* anaerobic speed reserve, *MLSS* maximal lactate steady state, *MSS* maximal sprinting speed, *RST* repeated-sprint training, *SIT* sprint interval training,  $\dot{V}O_{2max}$  maximal oxygen uptake,  $v\dot{V}O_{2max}$  minimal running speed required to elicit  $\dot{V}O_{2max}$ ,  $V_{\Delta 50}$  speed half way between  $v\dot{V}O_{2max}$  and *MLSS*,  $V_{crit}$  critical velocity,  $V_{IFT}$  peak speed reached at the end of the 30–15 Intermittent Fitness Test,  $V_{Inc.Test}$  peak incremental test speed



# HT long intervals



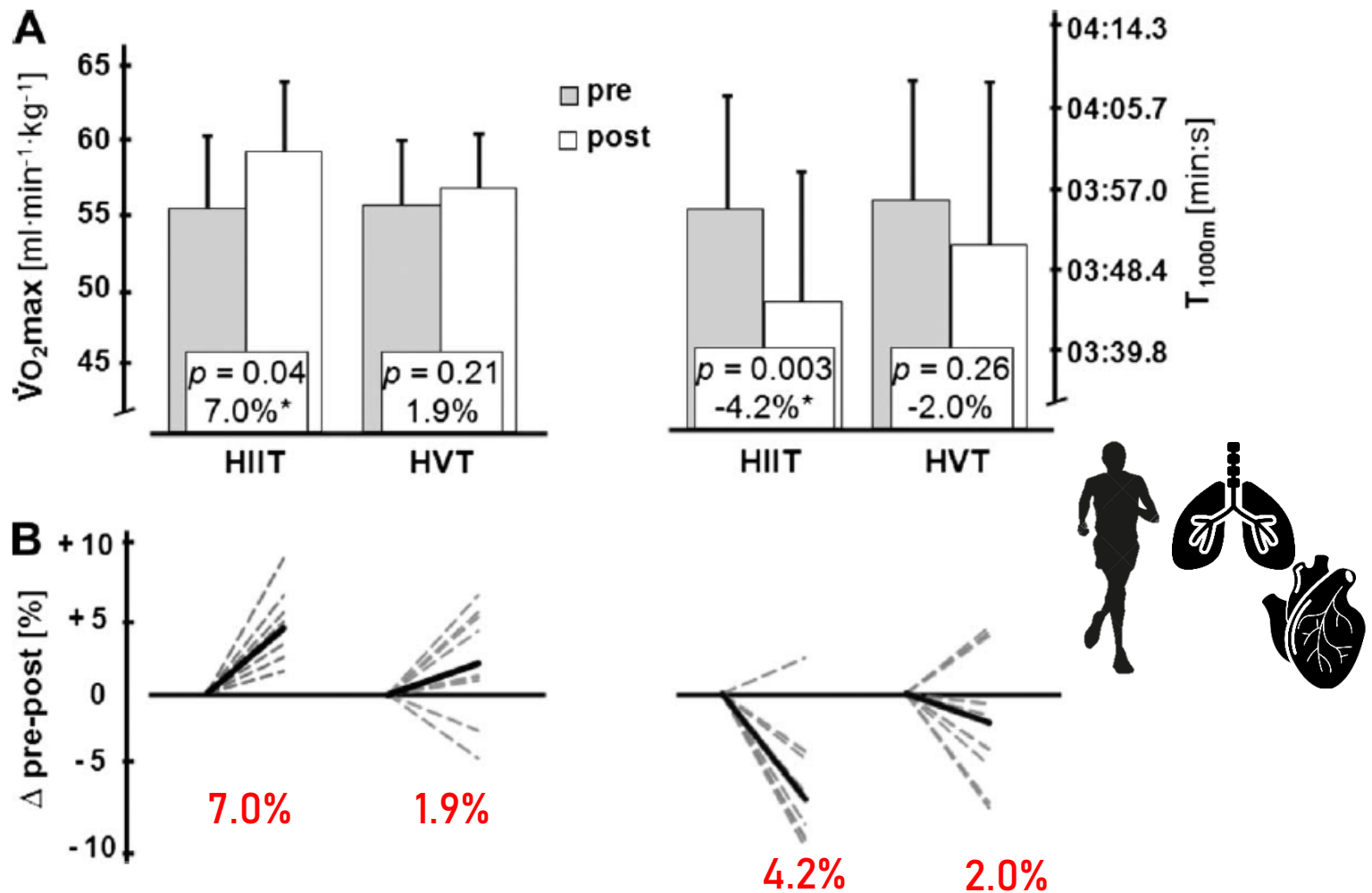
Sperlich, B., De Marées, M., Koehler, K., Linville, J., Holmberg, H. C., & Mester, J. (2011). Effects of 5 weeks of high-intensity interval training vs. volume training in 14-year-old soccer players. *The Journal of Strength & Conditioning Research*, 25(5), 1271-1278.

**TABLE 1.** Endurance training program and duration of each session for 5 weeks of HIIT and HVT.\*

Session	HIIT		HVT	
	Program	Total <i>T</i> (min)	Program	Total <i>T</i> (min)
1	8 × 1-min + 1-min break, 6 × 1-min + 1-min break	29	6 × 6-min + 3-min break	51
2	4 × 4-min + 3-min break	29	4 × 12-min Fartlek + 2-min break	54
3	4 × 4-min + 3-min break	29	2 × 30-min Fartlek + 5-min break	65
4	12 × 30-s Sprint, 30-s break, 6 × 2-min + 2-min break	31	4 × 12-min Fartlek + 2-min break	54
5	4 × 4-min + 3-min break	29	3 × 15-min Fartlek + 3-min break	51
6	5 × 800-m + 140-s break	25	2 × 25-min Fartlek + 5-min break	55
7	10 × 400-m + 90-s break	30	Continuous run of 8.9 km	60
8	4,1,1,4,2,4-min + 2-min break	26	5 × 10-min Fartlek + 1-min break	55
9	15 × 200-m + 80-s break	29	2 × 10-min Fartlek + 3-min break, 2 × 20-min Fartlek + 3-min break	69
10	12 × 30-s sprint, 30-s break, 6 × 2-min + 2-min break	31	3 × 15-min Fartlek + 3-min break	51
11	4 × 4-min + 3-min break	29	Continuous run of 8.9 km	60
12	4 × 4-min + 3-min break	29	2 × 30-min Fartlek + 5-min break	65
13	4 × 4-min + 3-min break	29	2 × 25-min Fartlek + 5-min break	55
Mean ± <i>SD</i>		28.8 ± 1.7		57.3 ± 5.9

\*HIIT = high intensity interval training; HVT = high volume training.

Sperlich, B., De Marées, M., Koehler, K., Linville, J., Holmberg, H. C., & Mester, J. (2011). Effects of 5 weeks of high-intensity interval training vs. volume training in 14-year-old soccer players. *The Journal of Strength & Conditioning Research*, 25(5), 1271-1278.



**Figure 3.** (A) Mean pre and postchanges in maximal oxygen uptake ( $\dot{V}O_2\text{max}$ ) and 1,000-m running time ( $T_{1000m}$ ) after short-term (5 weeks) high-intensity interval training (HIIT) and high-volume training (HVT). (B) Individual responses of maximal oxygen uptake ( $\dot{V}O_2\text{max}$ ) and 1,000-m running time ( $T_{1000m}$ ) after short-term (5 weeks) high-intensity interval training (HIIT) and high-volume training (HVT). Dashed lines show individual responses as pre-post differences in % ( $\Delta$  pre-post). Black lines represent the mean pre-post responds for either HIIT or HVT.

# Effects of high-intensity interval training on canoeing performance

MING-TA YANG<sup>1</sup>, MIEN-MIEN LEE<sup>2</sup>, SHU-CHING HSU<sup>2</sup>, & KUEI-HUI CHAN<sup>2</sup>



# Effects of high-intensity interval training on canoeing performance

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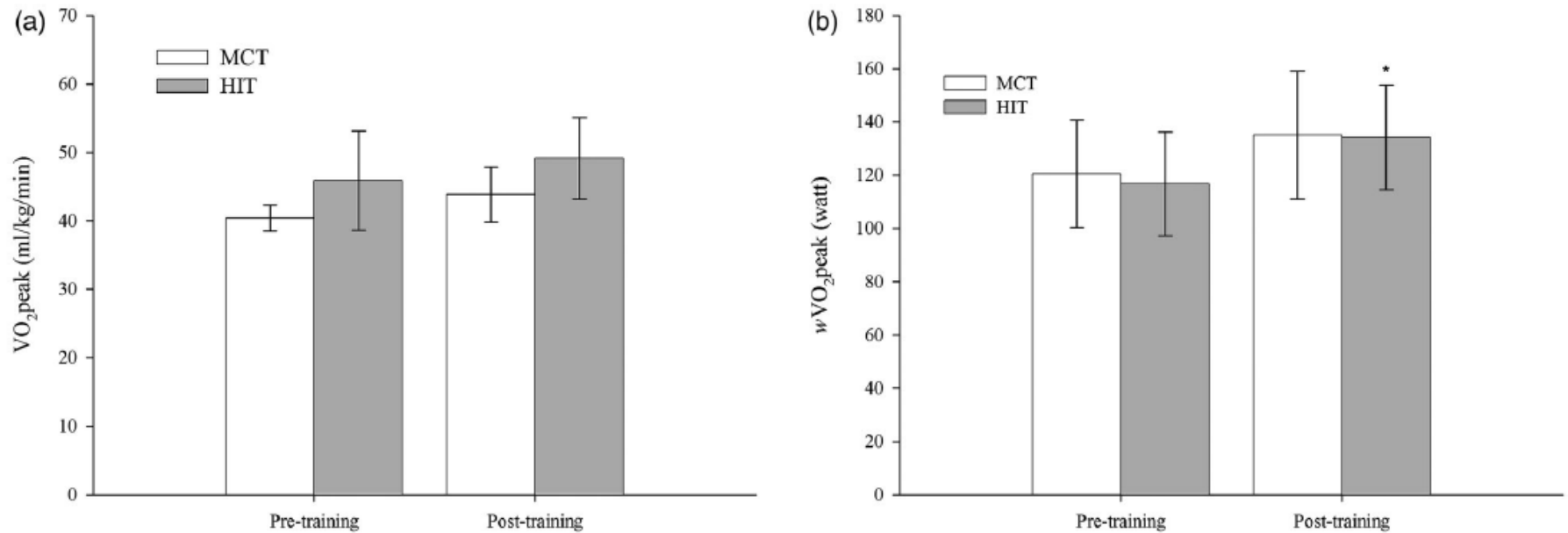


Figure 1. Changes in (a)  $\text{VO}_{2\text{peak}}$  and (b) power at  $\text{VO}_{2\text{peak}}$  ( $w\text{VO}_{2\text{peak}}$ ) after four weeks of training. \* Significantly higher than pre-training ( $P < .05$ ).

# Effects of high-intensity interval training on canoeing performance

MING-TA YANG<sup>1</sup>, MIEN-MIEN LEE<sup>2</sup>, SHU-CHING HSU<sup>2</sup>, & KUEI-HUI CHAN<sup>2</sup>

Table II. Changes in CE, aerobic capacity and performances after four weeks of training, Mean  $\pm$  SD.

Variable	HIIT group		MICT group	
	Pre	Post	Pre	Post
CEs (ml/kg/min)				
25 w	17.5 $\pm$ 2.8	17.5 $\pm$ 2.7	15.8 $\pm$ 3.0	14.9 $\pm$ 2.8
50 w	24.8 $\pm$ 4.3	25.2 $\pm$ 3.7	21.9 $\pm$ 3.8	21.9 $\pm$ 3.4
75 w	33.3 $\pm$ 5.8	32.3 $\pm$ 5.8	28.9 $\pm$ 3.9	28.3 $\pm$ 4.4
Performances (s)				
200 m	49.4 $\pm$ 2.4	47.6 $\pm$ 1.3*	48.3 $\pm$ 1.7	46.9 $\pm$ 2.1
500 m	137.6 $\pm$ 10.1	135.2 $\pm$ 6.3	137.4 $\pm$ 7.6	131.4 $\pm$ 5.0*
1000 m	295.8 $\pm$ 14.7	285.5 $\pm$ 9.6	293.9 $\pm$ 12.3	279.0 $\pm$ 11.9*
CV (m/s)	3.2 $\pm$ 0.1	3.3 $\pm$ 0.1	3.2 $\pm$ 0.2	3.4 $\pm$ 0.1*
AWC (m)	45.9 $\pm$ 8.5	42.3 $\pm$ 6.8	47.2 $\pm$ 9.1	42.1 $\pm$ 11.3

Note: HIIT, high-intensity interval training; MICT, moderate-intensity continuous training; CE, canoeing economy; CV, critical velocity; and AWC, anaerobic work capacity.

\*Significantly higher than pre-training ( $P < .05$ ).



# HI short intervals

5 equipes U19 e U17 alemãs profissionais de futebol (n = 88)

3 equipes (n = 44) realizaram  
HVT (5,5 semanas)

2 equipes (n = 32) realizaram  
HVT (5,5 semanas)

2 equipes (n = 14) realizaram  
HIIT (5,5 semanas)

1 equipe (n = 6) realizaram  
HVT (5,5 semanas)

cross-over

Desfechos:

*endurance*, altura do salto vertical e velocidade linear



7-10 mM



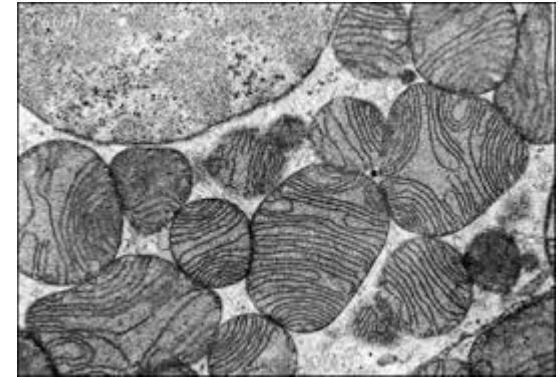
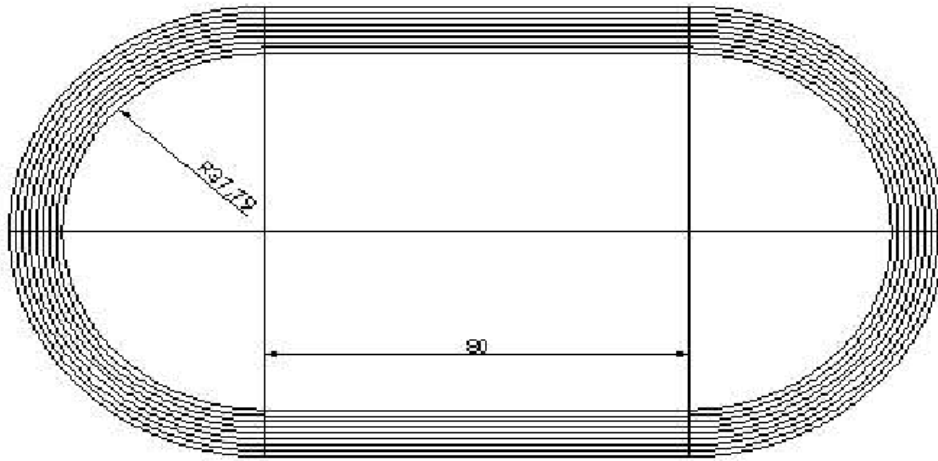
1-4 mM

Table I. Description of training programmes.

	HIIT	HVT
contents	2 x 12-15 x 30 s at 125% IAT velocity 20 s at 130% IAT velocity 15 s at 140% IAT velocity run:rest-ratio = 1:1 10 min light activity between series	Continuous endurance and fartlek runs (30 to 60 min) in the range of 80 to 95% IAT velocity
individual training sessions recorded	10.6 (1.3)	10.2 (1.2)
total individual training time (h:min)	5:49 (1:03)	8:00 (1:13)
	corresponding to 33 min per session	corresponding to 47 min per session
mean heart rate (incl. rest periods)	73.4 (3.6)% of peak heart rate 80.1 (4.2)% of IAT heart rate	77.7 (4.4)% of peak heart rate 85.3 (4.3)% of IAT heart rate
maximum heart rate	98.0 (5.2)% of peak heart rate	90.8 (5.2)% of peak heart rate

*Note:* Data as means and standard deviations. IAT = individual anaerobic threshold. HIIT = high-intensity interval training; HVT = high-volume continuous running.

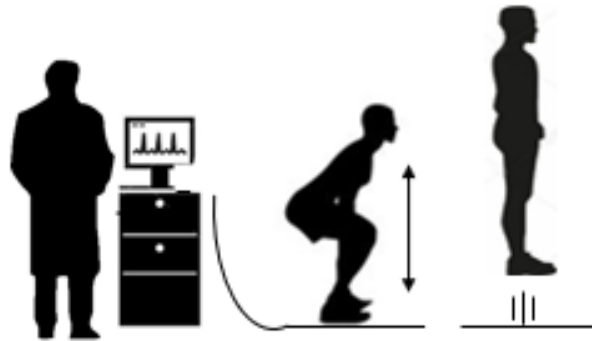
Faude, O., Schnittker, R., Schulte-Zurhausen, R., Müller, F., & Meyer, T. (2013). High intensity interval training vs. high-volume running training during pre-season conditioning in high-level youth football: a cross-over trial. *Journal of Sports Sciences*, 31(13), 1441-1450.



	HIIT		HVT	
IAT (km/h)	13,25 ± 0,63	13,71 ± 0,91	13,30 ± 0,96	14,09 ± 0,89
Vmax (km/h)	17,05 ± 1,06	17,30 ± 0,88	17,38 ± 0,84	17,62 ± 1,00

- ✓ Houve interação treino × tempo para IAT (HVT > HIIT)
- ✓ Houve incremento pequeno (*small*) para ambos os grupos na Vmax

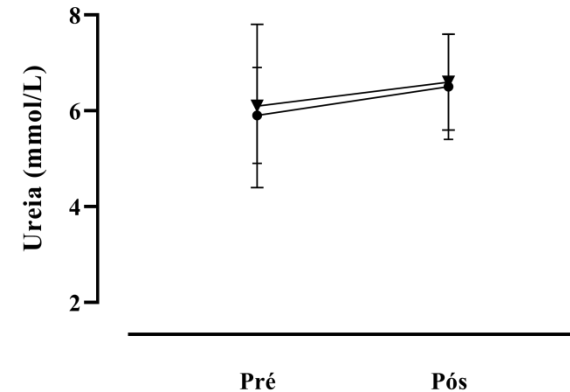
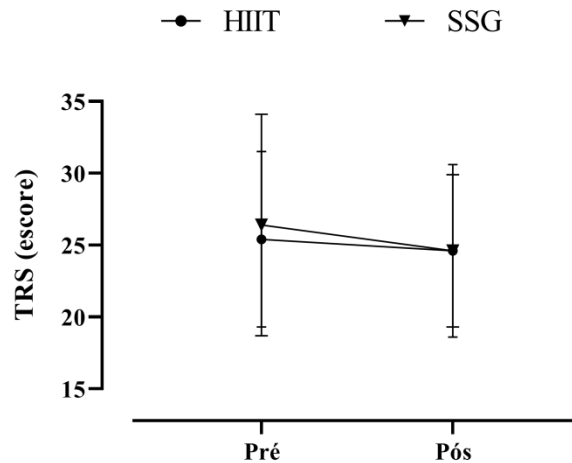
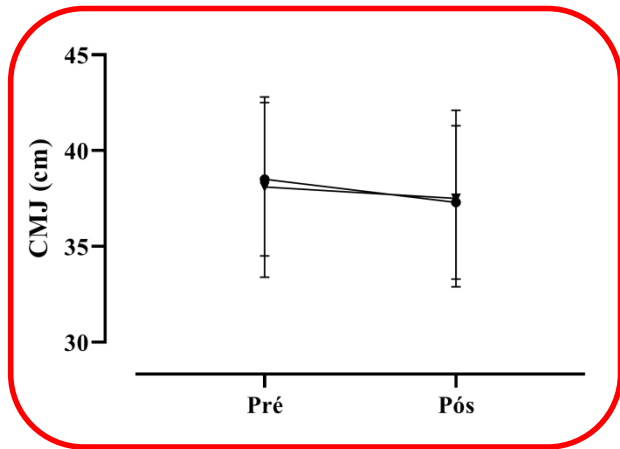
Faude, O., Schnittker, R., Schulte-Zurhausen, R., Müller, F., & Meyer, T. (2013). High intensity interval training vs. high-volume running training during pre-season conditioning in high-level youth football: a cross-over trial. *Journal of Sports Sciences*, 31(13), 1441-1450.



	HIIT		HVT	
CMJ (cm)	38,0 ± 4,0	36,3 ± 5,0	39,4 ± 4,6	38,1 ± 4,7
DJ (cm)	32,8 ± 4,8	31,6 ± 4,6	34,2 ± 4,2	32,0 ± 3,9

✓ Ambos os grupos reduziram a altura de salto vertical após o treinamento

Faude, O., Schnittker, R., Schulte-Zurhausen, R., Müller, F., & Meyer, T. (2013). High intensity interval training vs. high-volume running training during pre-season conditioning in high-level youth football: a cross-over trial. *Journal of Sports Sciences*, 31(13), 1441-1450.



Faude, O., Steffen, A., Kellmann, M., & Meyer, T. (2014). The effect of short-term interval training during the competitive season on physical fitness and signs of fatigue: A crossover trial in high-level youth football players. *International journal of sports physiology and performance*, 9(6), 936-944.

# Treinamento concorrente

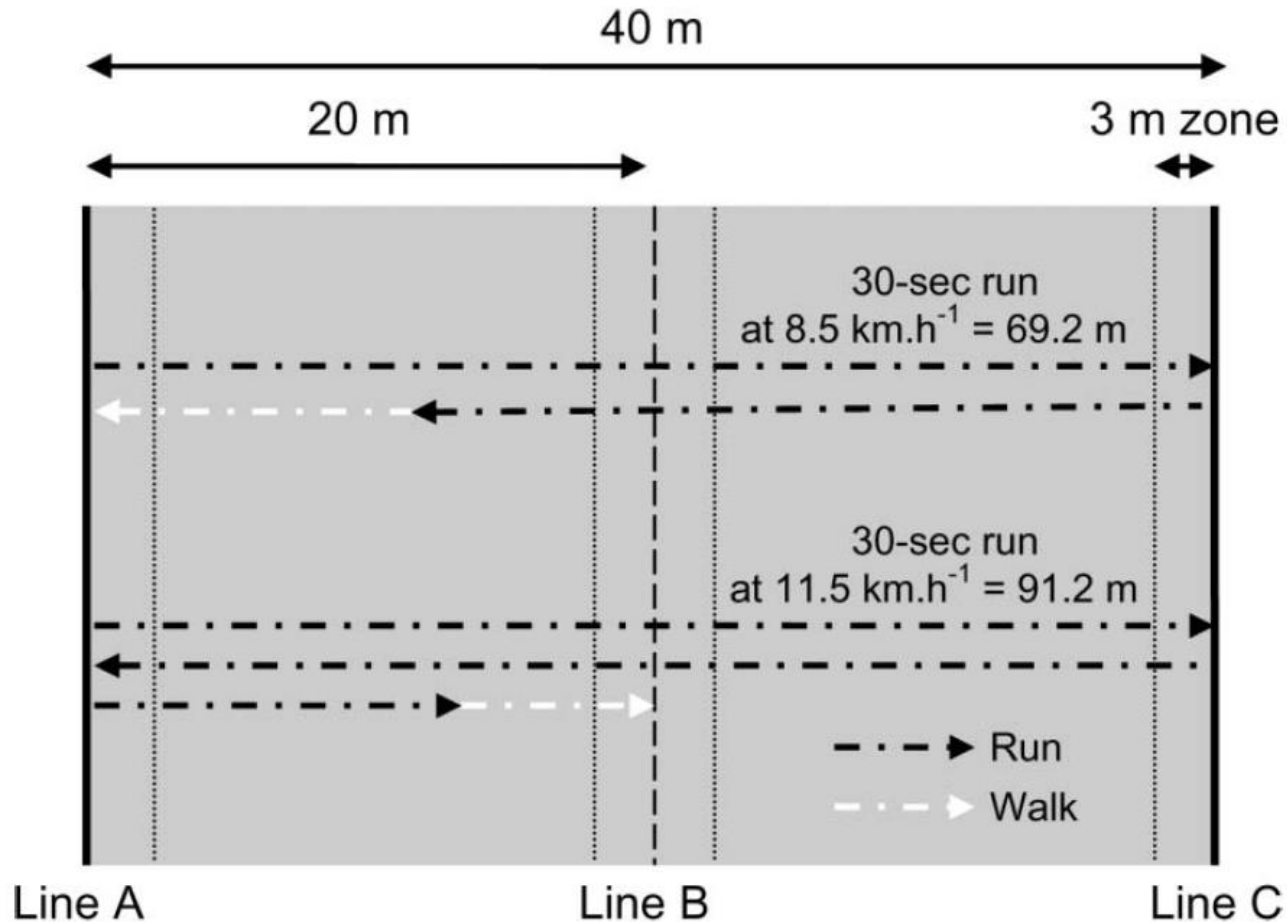
**Adaptações ao  
treinamento aeróbio**



**Adaptações ao  
treinamento  
neuromuscular**



# HT short intervals



# HT short intervals



9 semanas de intervenção

*Sprints* repetidos

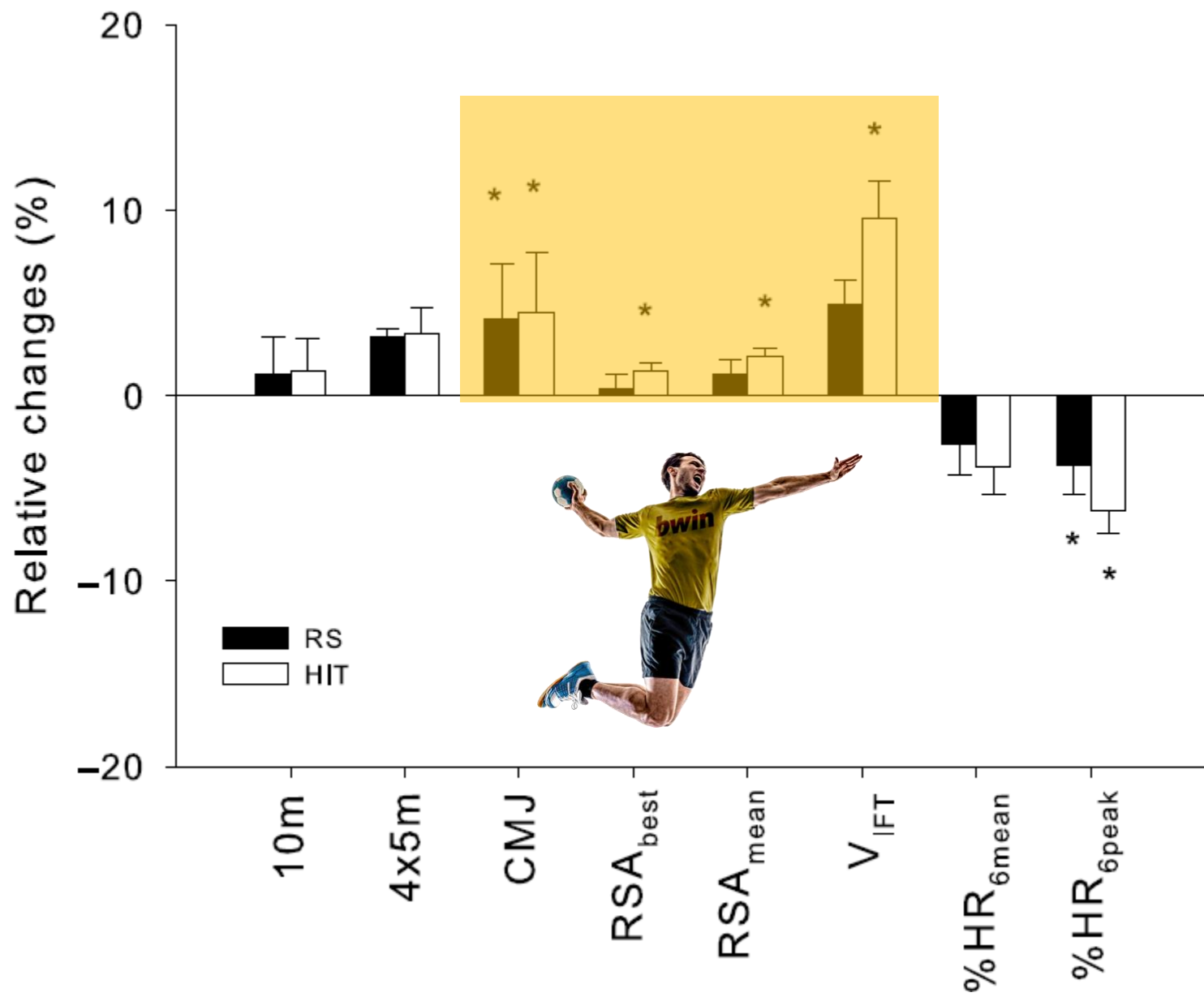
$2 \times [2 \times (6 \times 2 \times 20 \text{ m}(23' \text{a}))]$

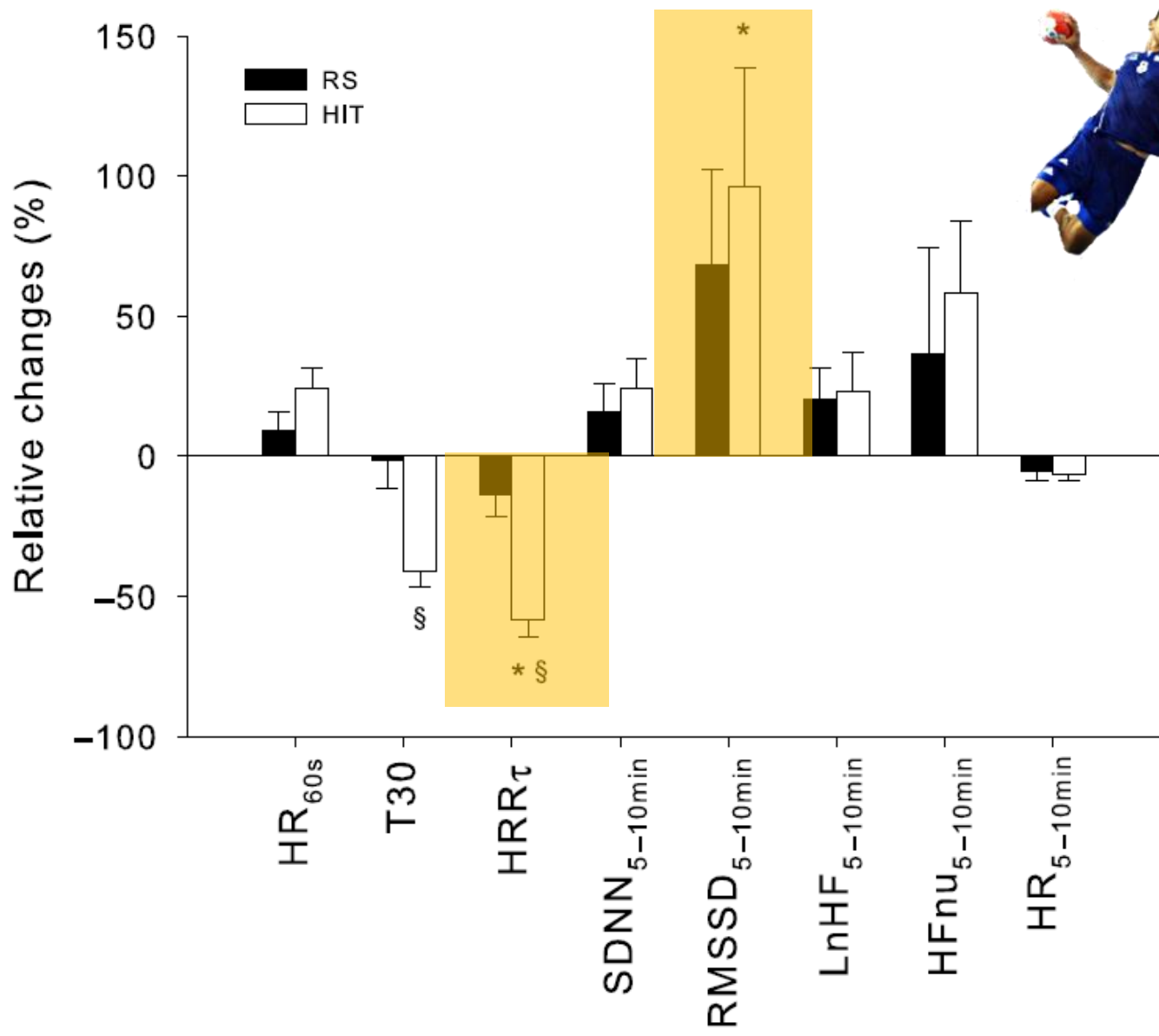
HIT

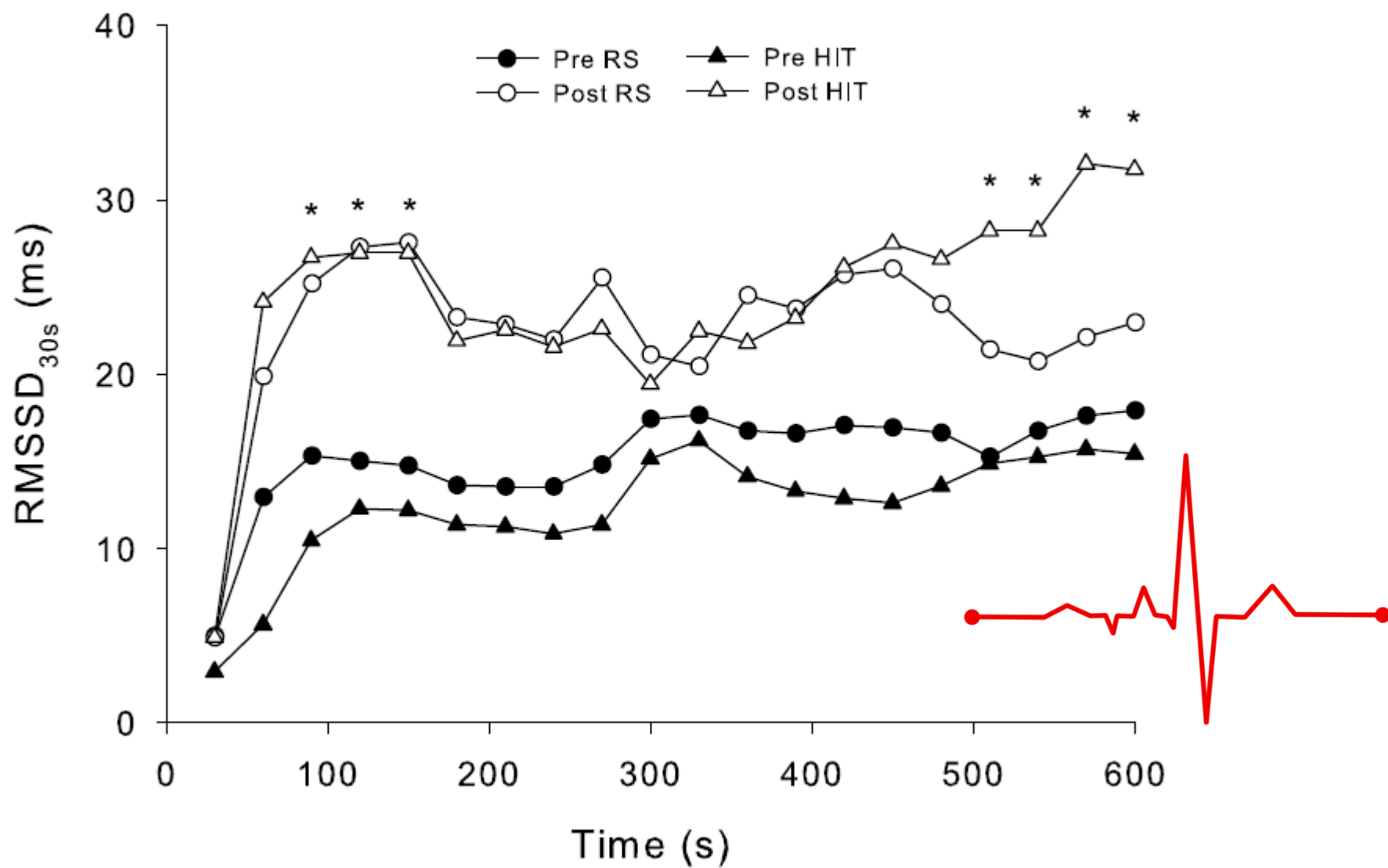
$2 \times [16 \times (15' (95\%) - 15' \text{ p})]$

30-15<sub>FT</sub>, salto com contra movimento, *sprint* de 10 m 4 × 5 m (*shuttle run*),  
RSA e teste submáximo de 6 min a 60% da V<sub>IFT</sub> (reativação vagal)









24 jogadores de  
futebol e  
basquetebol  
amadores

HIT (2 × [8 × 30 corridas linear a 90-100% HRmax])

5 semanas – 2 × por semana



HIT (2 × [8 × 30 corridas lineares a 90-100% HRmax])

+

Lunges, unilateral kicks e half-squats (2-3 × 5 reps)



Sanchez-Sanchez, J., Gonzalo-Skok, O., Carretero, M., Pineda, A., Ramirez-Campillo, R., & Nakamura, F. Y. (2019). EFFECTS OF CONCURRENT ECCENTRIC OVERLOAD AND HIGH-INTENSITY INTERVAL TRAINING ON TEAM SPORTS PLAYERS' PERFORMANCE. *Kinesiology: International journal of fundamental and applied kinesiology*, 51(1), 119-126.

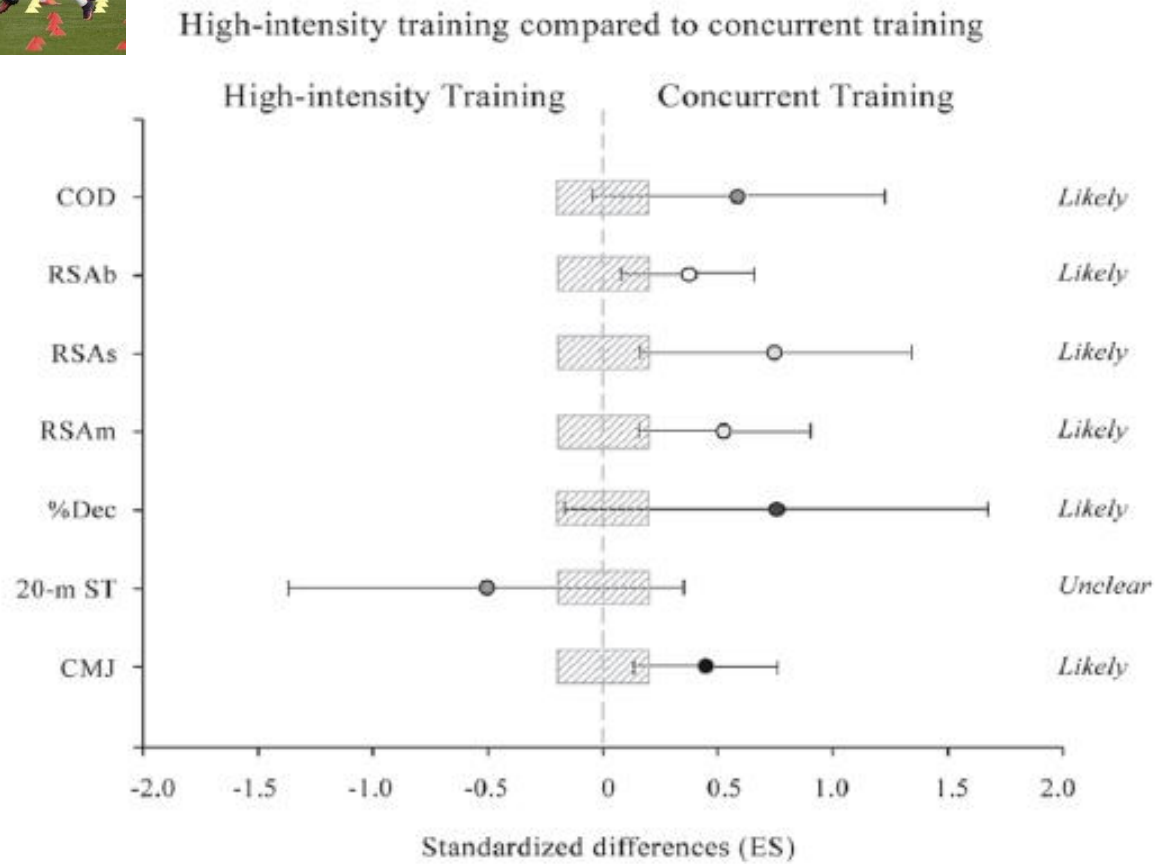
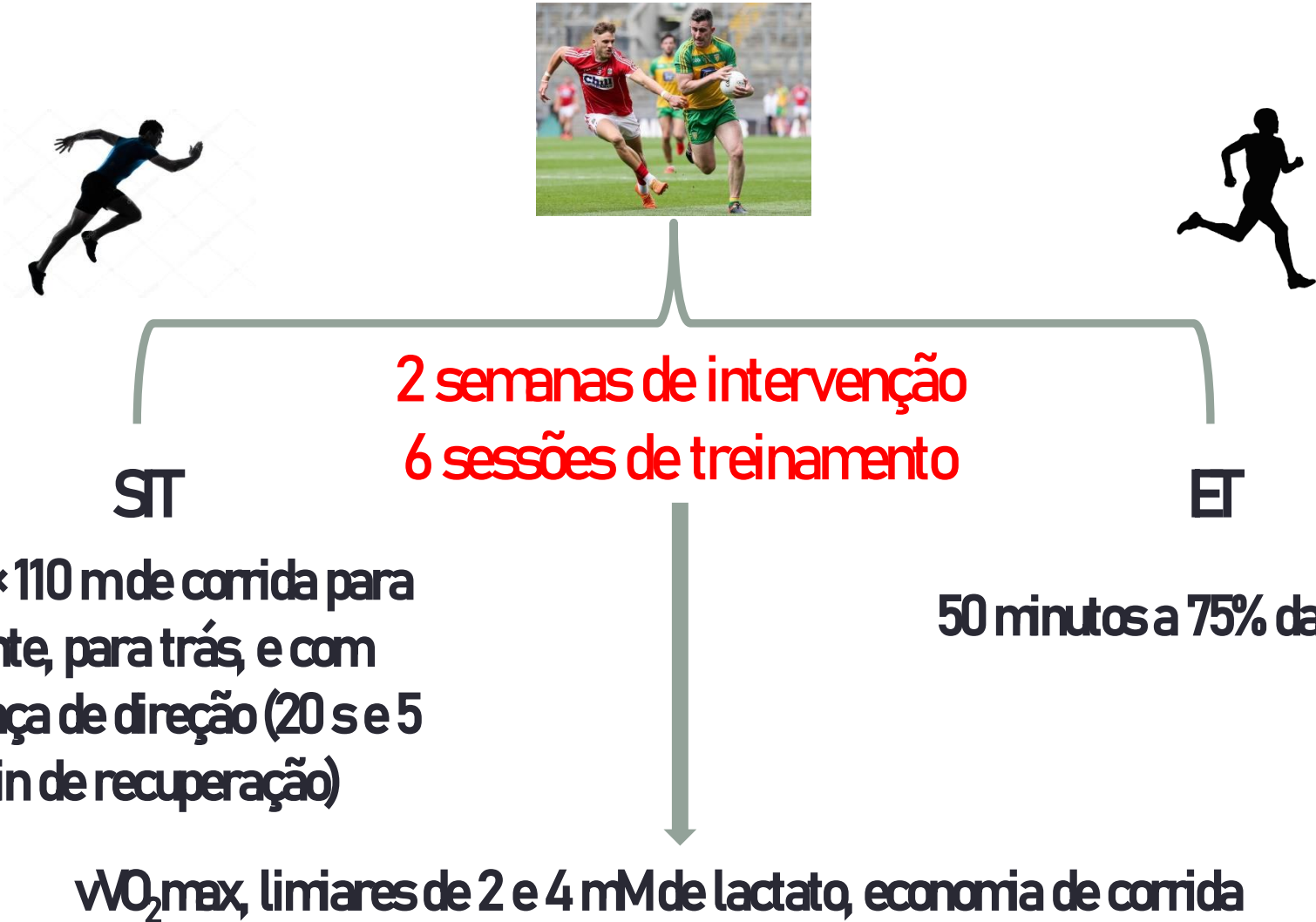


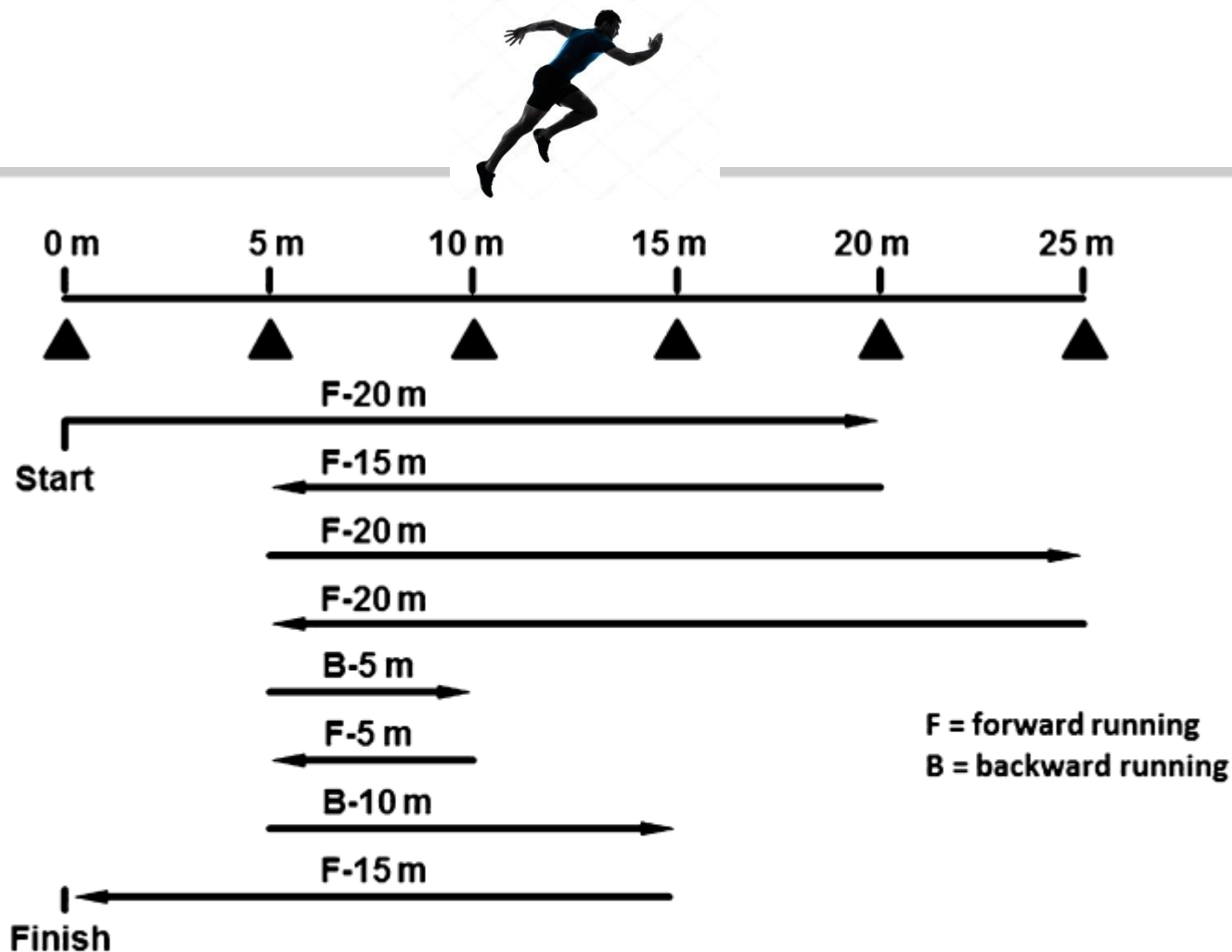
Figure 2. Effects of high-intensity training compared to concurrent training.





# Sprint interval training





**Figure 1.** Schematic of the SIT running protocol. Each interval run was 110 m in total distance and involved forward and backward sprints over distances ranging from 5 to 20 m. A set consisted of  $3 \times 110$  runs with a 20-second recovery period between each run. Each training session consisted of 3 sets of high-intensity running interspersed with a 5-minute recovery period between sets. SIT = sprint interval training.





**TABLE 1.** Blood lactate concentration before, during, and after each SIT and ET training session.\*†

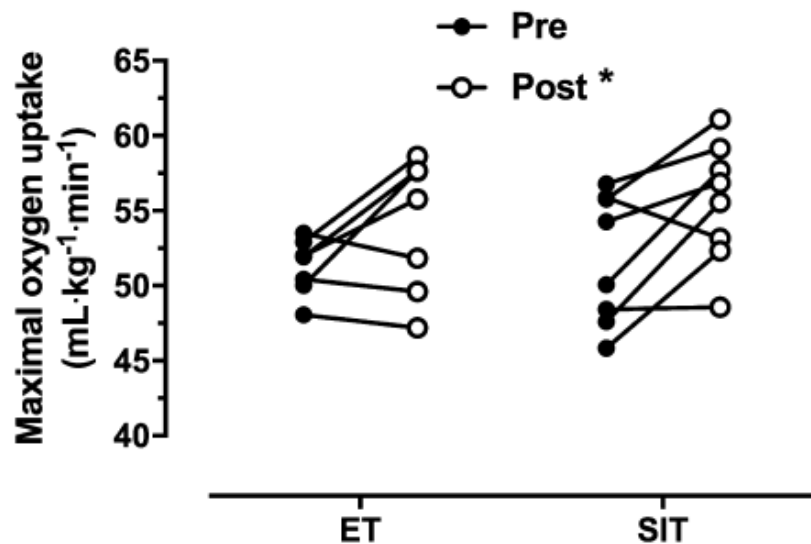
	SIT				ET	
	Preexercise	Set 1	Set 2	Postexercise	Preexercise	Postexercise
Session 1	1.20 ± 0.36	9.30 ± 2.43‡	10.70 ± 2.50‡	11.41 ± 0.50‡§	1.03 ± 0.26	5.64 ± 3.36‡
Session 2	1.03 ± 0.21	8.83 ± 3.13‡	11.64 ± 1.04‡	12.19 ± 1.32‡§	1.09 ± 0.20	4.54 ± 3.30‡
Session 3	1.23 ± 0.41	7.58 ± 3.32‡	12.06 ± 1.23‡	12.45 ± 1.59‡§	0.97 ± 0.15	4.66 ± 3.51‡
Session 4	1.29 ± 0.36‡	7.63 ± 3.71‡	10.94 ± 2.96‡	11.88 ± 1.69‡§	0.90 ± 0.17	2.97 ± 2.27‡
Session 5	1.29 ± 0.39	6.84 ± 3.42‡	13.19 ± 2.08‡	13.26 ± 1.72‡§	1.01 ± 0.38	3.64 ± 2.39‡
Session 6	1.05 ± 0.31	7.46 ± 3.93‡	10.90 ± 3.30‡	12.90 ± 2.16‡§	0.93 ± 0.34	3.94 ± 2.14‡

\*SIT = sprint interval training; ET = endurance training.

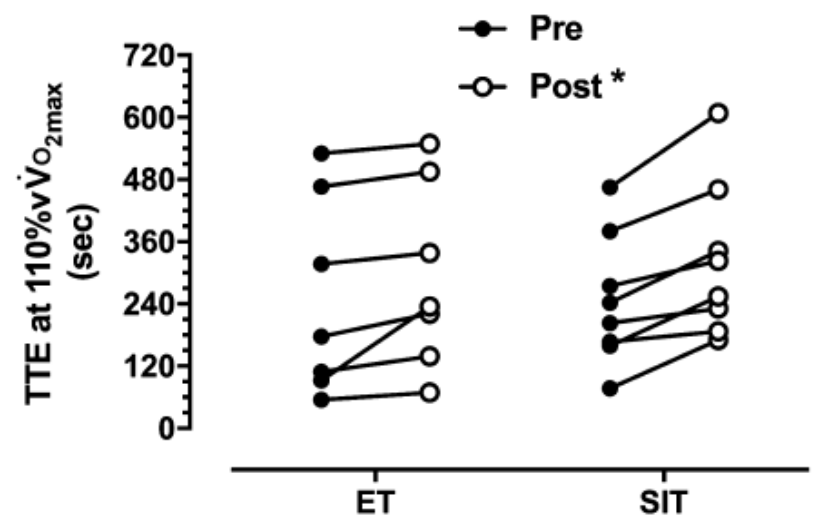
†Values are mean ± SD, mmol·L<sup>-1</sup>.

‡Main effect for time ( $p \leq 0.05$ ) vs. preexercise.

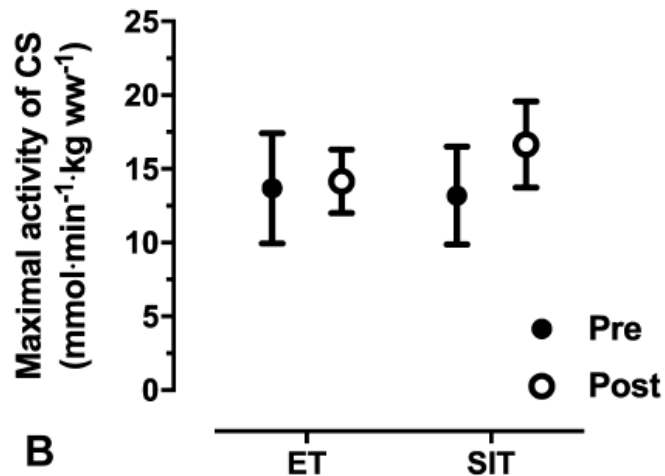
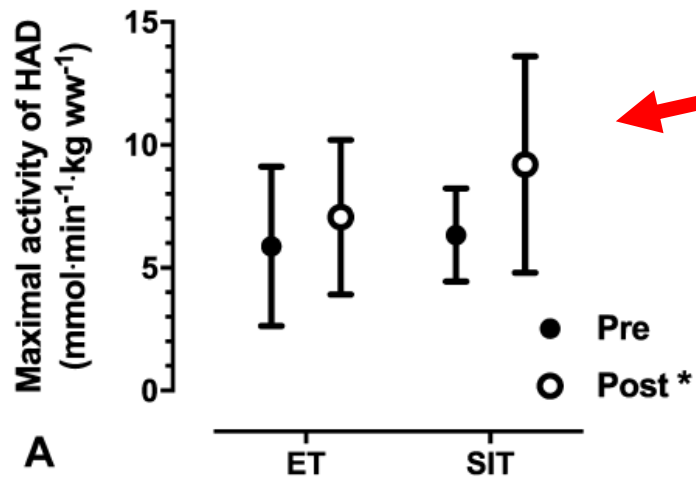
§Main effect for time × group interaction ( $p \leq 0.05$ ) vs. post-ET.



**Figure 2.** Changes in maximal oxygen uptake ( $\dot{V}O_{2\max}$ ) in response to 2 weeks of endurance training (ET) or sprint interval training (SIT). Data are mean  $\pm$  SD. Filled boxes (■) represent pretraining values, and open boxes (□) represent posttraining values. \*Main effect for time ( $p < 0.008$ ) vs. preexercise.

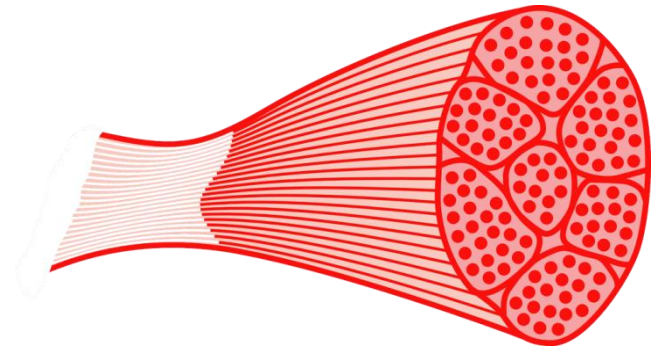


**Figure 3.** Changes in high-intensity endurance capacity assessed by time to exhaustion at 110%  $\dot{V}O_{2\max}$  in response to 2 weeks of endurance training (ET) or sprint interval training (SIT). Data are mean  $\pm$  SD. Filled circles (●) represent pretraining values, and open circles (○) represent posttraining values. \*Main effect for time ( $p \leq 0.05$ ) vs. preexercise. TTE = time to exhaustion.



**Figure 4.** Changes in maximal enzymatic activity of (A) 3-β-hydroxylacyl coenzyme A dehydrogenase (HAD) and (B) citrate synthase (CS) in response to 2 weeks of endurance training (ET) or sprint interval training (SIT). Data are mean ± SD. Filled boxes (■) represent pretraining values, and open boxes (□) represent posttraining values. \*Main effect for time ( $p \leq 0.05$ ) vs. preexercise.

3-hidroxiacil-CoA desidrogenase



# Treino aeróbio/anaeróbio

**Membros  
superiores**

**Membros inferiores  
ou *whole body***





# PHYSIOLOGICAL ADAPTATIONS TO HIGH-INTENSITY INTERVAL AND CONTINUOUS TRAINING IN KAYAK ATHLETES

APOSTOLOS PAPANDREOU,<sup>1</sup> ANASTASSIOS PHILIPPOU,<sup>2</sup> ELIAS ZACHAROGIANNIS,<sup>1</sup> AND MARIA MARIDAKI<sup>1</sup>



**TABLE 1.** The exercise training program used in the HIIT group consisted of 24 sessions of 8 repetitions  $\times$  30-second paddling at 120%  $\dot{V}O_2\text{max}$  with 60 seconds of passive recovery between repetitions in each session.\*

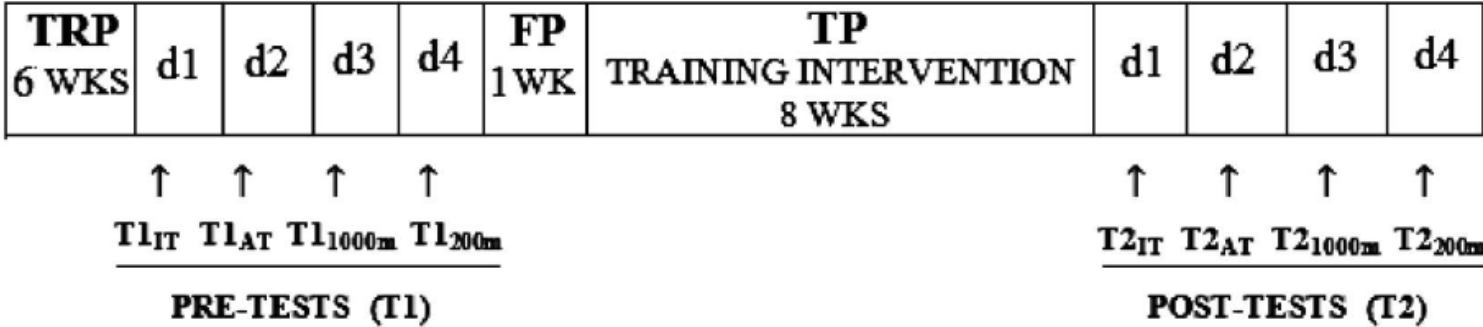
	Duration (min)	Frequency (sessions)	Intensity	Recovery time	Warm-up
1 session	4 (8 $\times$ 30 sec)	1	120% $\dot{V}O_2\text{max}$	60 sec	5 min
1 wk	12	3		—	—
4 wk	48	12		—	—
8 wk	96	24		—	—

\*HIIT = high-intensity interval training.

## Treino contínuo – 60 min a 70% do $\dot{V}O_2\text{max}$

# PHYSIOLOGICAL ADAPTATIONS TO HIGH-INTENSITY INTERVAL AND CONTINUOUS TRAINING IN KAYAK ATHLETES

APOSTOLOS PAPANDREOU,<sup>1</sup> ANASTASSIOS PHILIPPOU,<sup>2</sup> ELIAS ZACHAROGIANNIS,<sup>1</sup> AND MARIA MARIDAKI<sup>1</sup>



**Figure 1.** Schematic illustration of the experimental design of the study. Before entering the training program, participants had completed a 6-week transition recovery period (TRP). The participants were being familiarized with the testing protocols and the kayak ergometer within a familiarization period (FP) of 1 week. The pre-training (T1) and the post-training phase (T2) consisted of 4 tests; the incremental test performed on day 1 (T1<sub>IT</sub>), the kayak-type Wingate anaerobic test on day 2 (T1<sub>AT</sub>), the 1,000-m performance time test on day 3 (T1<sub>1,000 m</sub>), and the 200-m performance time test performed on day 4 (T1<sub>1,200 m</sub>). The volunteers of the HIIT and CT training groups followed different exercise training programs (TPs), each lasting for 8 weeks (see text, for details). CT = continuous training.

# PHYSIOLOGICAL ADAPTATIONS TO HIGH-INTENSITY INTERVAL AND CONTINUOUS TRAINING IN KAYAK ATHLETES

APOSTOLOS PAPANDREOU,<sup>1</sup> ANASTASSIOS PHILIPPOU,<sup>2</sup> ELIAS ZACHAROGIANNIS,<sup>1</sup> AND MARIA MARIDAKI<sup>1</sup>



- Teste incremental máximo
- Wingate
- 200-me 1000-m
- Economia de movimento
- Limiar ventilatório 2

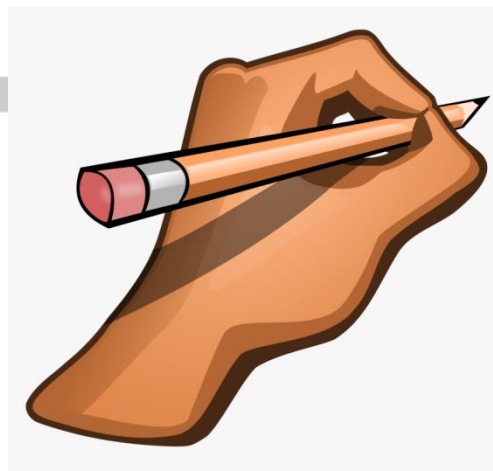
**TABLE 3.** Physiological and performance variables measured before (pre) and after (post) the experimental period in the training (CT and HIIT) and control (C) groups (mean  $\pm$  SD)\*.

Variable	CT pre	CT post	HIIT pre	HIIT post	C pre	C post
$\dot{V}O_{2\max}$ (ml·kg <sup>-1</sup> ·min <sup>-1</sup> )	45.31 $\pm$ 6.70	44.41 $\pm$ 6.10	40.08 $\pm$ 4.80	42.10 $\pm$ 5.80	44.89 $\pm$ 7.30	44.23 $\pm$ 5.40
PS <sub><math>\dot{V}O_{2\max}</math></sub> (k·h <sup>-1</sup> )	12.62 $\pm$ 1.70	13.70 $\pm$ 1.41 <sup>‡</sup>	11.46 $\pm$ 1.87	12.72 $\pm$ 1.59 <sup>‡</sup>	12.35 $\pm$ 1.20	12.25 $\pm$ 1.10
$\dot{V}O_2$ at VT2 (ml·kg <sup>-1</sup> ·min <sup>-1</sup> )	35.83 $\pm$ 5.88	35.10 $\pm$ 4.68	32.08 $\pm$ 6.67	33.51 $\pm$ 7.94	35.22 $\pm$ 3.98	35.36 $\pm$ 3.85
PS <sub>VT2</sub> (km·h <sup>-1</sup> )	9.98 $\pm$ 1.41	10.86 $\pm$ 1.49	9.17 $\pm$ 1.79	10.13 $\pm$ 1.59 <sup>‡</sup>	9.71 $\pm$ 1.02	9.8 $\pm$ 1.72
PS <sub>peak</sub> (km·h <sup>-1</sup> )	17.25 $\pm$ 2.80	18.66 $\pm$ 2.80 <sup>‡</sup>	15.95 $\pm$ 2.80	17.58 $\pm$ 3.30 <sup>‡</sup>	15.97 $\pm$ 1.80	16.23 $\pm$ 1.53
[La <sup>3+</sup> 2] (mmol·L <sup>-1</sup> )	12.95 $\pm$ 2.60	14.78 $\pm$ 3.60	12.67 $\pm$ 3.30	12.90 $\pm$ 3.80	13.25 $\pm$ 1.70	13.35 $\pm$ 1.60
PEs (km·h <sup>-1</sup> )	9.64 $\pm$ 1.70	10.94 $\pm$ 2.10 <sup>‡</sup>	8.28 $\pm$ 1.33	10.39 $\pm$ 1.48 <sup>‡</sup>	9.50 $\pm$ 1.48	9.83 $\pm$ 1.05
PS <sub>R</sub>	7.29 $\pm$ 2.74	9.80 $\pm$ 2.53	8.39 $\pm$ 2.77	10.23 $\pm$ 3.03	8.18 $\pm$ 2.83	8.46 $\pm$ 6.31
HR <sub>peak</sub> (b·min <sup>-1</sup> )	194.50 $\pm$ 8.00	197.00 $\pm$ 9.80	194.00 $\pm$ 9.73	197.50 $\pm$ 11.01	197.75 $\pm$ 3.69	196.62 $\pm$ 3.62
T <sub>1,000 m</sub> (s)	266.63 $\pm$ 20.36	261.50 $\pm$ 20.34 <sup>‡</sup>	279.13 $\pm$ 29.22	273.38 $\pm$ 28.80 <sup>‡</sup>	273.04 $\pm$ 28.80	274.00 $\pm$ 21.45
T <sub>200 m</sub> (s)	45.65 $\pm$ 5.32	45.62 $\pm$ 5.28	47.00 $\pm$ 6.80	44.98 $\pm$ 6.23 <sup>‡</sup>	44.57 $\pm$ 5.16	45.33 $\pm$ 5.11

\* $\dot{V}O_{2\max}$  = maximum oxygen uptake; PS <sub>$\dot{V}O_{2\max}$</sub>  = paddling speed at maximum oxygen uptake;  $\dot{V}O_2$  at VT2 =  $\dot{V}O_2$  at ventilatory threshold; PS<sub>VT2</sub> = paddling speed at ventilatory threshold 2; PS<sub>peak</sub> = peak paddling speed in the kayak-type Wingate test; [La<sup>3+</sup>2] = lactate accumulation 3 minute after the  $\dot{V}O_{2\max}$  test; PEs = paddling economy speed (speed at 75% of  $\dot{V}O_{2\max}$ ); PS<sub>R</sub> = reduction of peak speed in the 30-second Wingate test; HR<sub>peak</sub> = peak heart rate; T<sub>1,000 m</sub> = time needed to cover 1,000-m olympic distance; T<sub>200 m</sub> = time needed to cover 200-m olympic distance.

<sup>†</sup>Significantly different compared with pre values:  $p < 0.05$ .

<sup>‡</sup>Significantly different compared with pre values:  $p < 0.001$ .





**TABLE 4.** Percentage changes in physiological variables after the 8-week experimental period in the training (CT and HIIT) and control (C) groups (mean  $\pm$  SD).\*

Variable	CT	HIIT	C	ANOVA <i>p</i>
$\dot{V}O_{2\max}$	$-1.79 \pm 10.11\%$	$5.21 \pm 4.72\%$	$-0.75 \pm 7.19\%$	0.161
PS <sub>peak</sub>	$8.44 \pm 4.50\%^\dagger$	$9.95 \pm 2.72\%^\ddagger$	$1.90 \pm 5.20\%$	<b>0.003</b>
[La <sup>+2</sup> ]	$17.73 \pm 38.85\%$	$2.34 \pm 17.60\%$	$1.00 \pm 7.52\%$	0.349
PS <sub><math>\dot{V}O_{2\max}</math></sub>	$6.26 \pm 6.75\%^\dagger$	$11.85 \pm 8.17\%$	$-0.65 \pm 5.20\%$	<b>0.003</b>
PE <sub>S</sub>	$0.67 \pm 18.09\%^\dagger  $	<b><math>17.68 \pm 23.71\%^\S</math></b>	$-3.53 \pm 18.48\%$	<b>0.019</b>
$\dot{V}O_2$ at VT2	$-2.04 \pm 3.08\%$	$4.46 \pm 2.90\%$	$0.40 \pm 0.41\%$	0.160
PS <sub>VT2</sub>	$9.16 \pm 9.67\%$	$11.62 \pm 14.82\%$	$1.38 \pm 7.52\%$	0.162
PS <sub>R</sub>	$-2.51 \pm 9.67\%$	$-1.84 \pm 14.62\%$	$0.28 \pm 7.52\%$	0.330
HR <sub>peak</sub>	$1.28 \pm 2.44\%$	$1.92 \pm 2.13\%$	$0.46 \pm 1.79\%$	0.408
T <sub>1,000 m</sub>	$-1.90 \pm 2.15\%$	<b><math>-2.05 \pm 0.90\%</math></b>	$0.18 \pm 0.93\%$	0.052
T <sub>200 m</sub>	$-0.00067 \pm 8.24\%$	$-3.57 \pm 1.64\%$	$0.55 \pm 0.98\%$	0.259

\* $\dot{V}O_{2\max}$  = maximum oxygen uptake; PS<sub>peak</sub> = peak paddling speed in the kayak-type Wingate test; [La<sup>+2</sup>] = lactate accumulation 3 minute after the  $\dot{V}O_{2\max}$  test; PS <sub>$\dot{V}O_{2\max}$</sub>  = paddling speed at maximum oxygen uptake; bold entries = statistical significance; PEs = paddling economy speed (speed at 75% of  $\dot{V}O_{2\max}$ );  $\dot{V}O_2$  at VT2 =  $\dot{V}O_2$  at ventilatory threshold; PS<sub>VT2</sub> = paddling speed at ventilatory threshold 2; PS<sub>R</sub> = reduction of peak speed in the 30-second Wingate test; HR<sub>peak</sub> = peak heart rate; T<sub>1,000 m</sub> = 1,000-m olympic distance time test; T<sub>200 m</sub> = 200-m olympic distance time test.

<sup>†</sup>Significantly different compared with the control group; *p* < 0.05.

<sup>‡</sup>Significantly different compared with the control group; *p* < 0.01.

<sup>§</sup>Significantly different compared with the control group; *p* < 0.001.

<sup>||</sup>Significantly different compared with the HIIT group; *p* < 0.05.

# PRACTICAL MODEL OF LOW-VOLUME PADDLING-BASED SPRINT INTERVAL TRAINING IMPROVES AEROBIC AND ANAEROBIC PERFORMANCES IN PROFESSIONAL FEMALE CANOE POLO ATHLETES

MOHSEN SHEYKHOLOVAND,<sup>1,2</sup> ERFAN KHALILI,<sup>3</sup> MOHAMMADALI GHARAAT,<sup>4</sup>  
HAMID ARAZI,<sup>1</sup> MOUSA KHALAFI,<sup>1</sup> AND BAHMAN TARVERDIZADEH<sup>5</sup>



- Teste incremental máximo



- Wingate

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5 × 5 s, 10 s de recuperação

3, 4, 5 e 6 séries

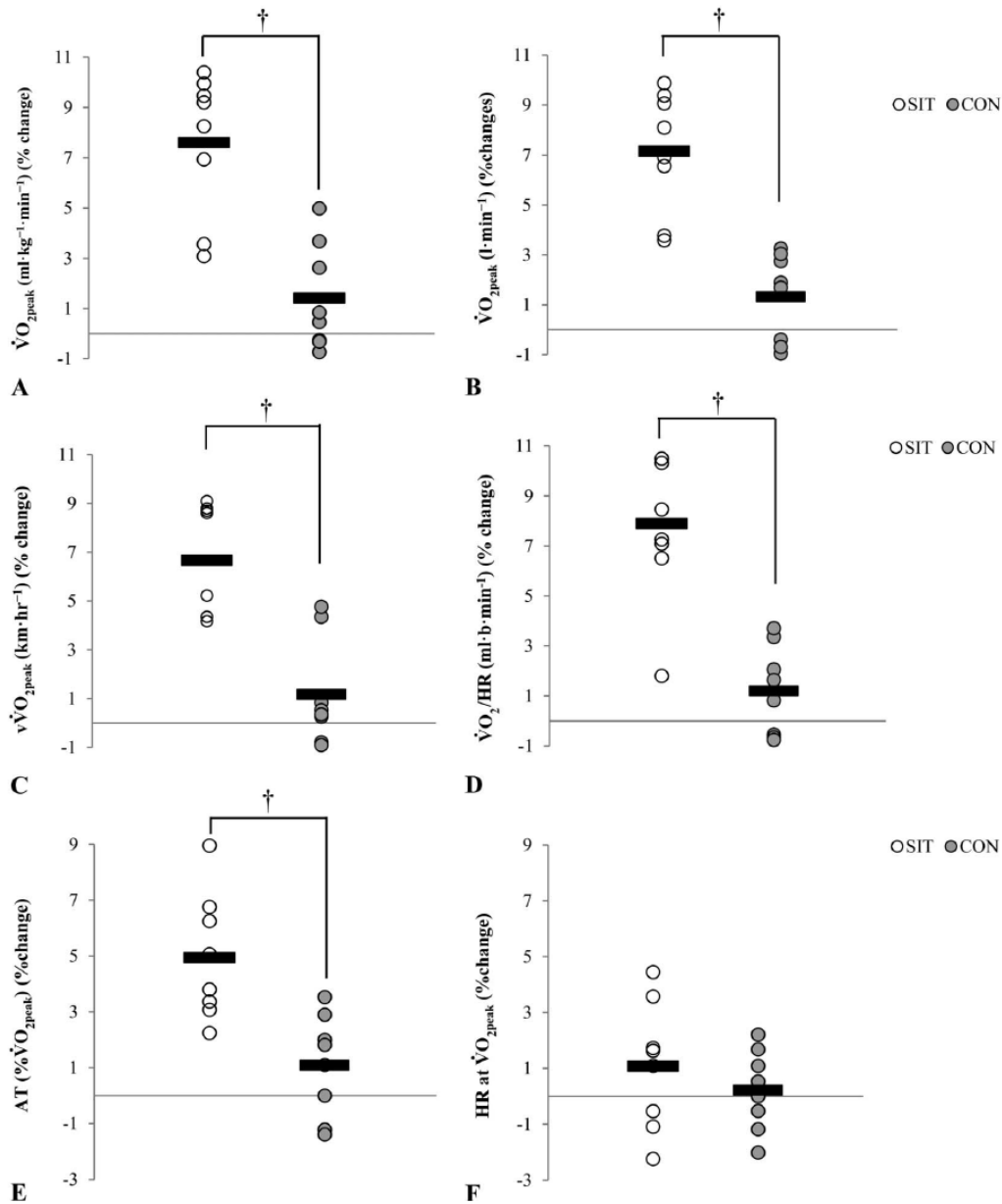
3 min entre as séries

**TABLE 1.** Training program for each group.\*†

Days of wk	SIT group	CON group
Monday	Canoe polo training	Canoe polo training
Tuesday	SIT (MO) Weight training (EV)	Weight training
Wednesday	Canoe polo training	Canoe polo training
Thursday	SIT (MO) Canoe polo training (EV)	Canoe polo training
Friday	Rest	Rest
Saturday	Weight training	Weight training
Sunday	SIT (MO) Canoe polo training (EV)	Canoe polo training

\*SIT = sprint interval training; CON = control group; MO = morning; EV = evening.

†N = 8 for each group.



**Figure 1.** Effect of 4 weeks of sprint interval training (SIT) or control (CON) on relative percent change in (A) relative  $\dot{V}O_{2peak}$ , (B) absolute  $\dot{V}O_{2peak}$ , (C)  $\dot{V}O_{2peak}$ , (D)  $\dot{V}O_2/HR$ , (E) anaerobic threshold (AT), and (F) HR@ $\dot{V}O_{2peak}$ . Circles show individual percentage change from baseline and horizontal bars show mean group percentage change from baseline (x-axes).  $n = 8$  for SIT and  $n = 8$  for CON. †Significant difference between SIT and CON ( $p < 0.05$ ).



**TABLE 2.** Pretraining vs. posttraining peak power output and mean power output elicited during 4 consecutive Wingate trials.\*†

	SIT		CON	
	Pre	Post	Pre	Post
Peak power output (W)				
1st	365 ± 62	‡407 ± 66	377 ± 60	369 ± 60
%Δ	§+11.5		-2.1	
2nd	370 ± 101	‡405 ± 77	386 ± 64	388 ± 44
%Δ	§+9.4		+0.5	
3rd	355 ± 89	‡387 ± 67	365 ± 57	367 ± 59
%Δ	+9.0		+0.5	
4th	331 ± 72	‡375 ± 65	361 ± 65	358 ± 30
%Δ	+13.3		-0.8	
Mean power output (W)				
1st	288 ± 45	299 ± 34	293 ± 37	294 ± 38
%Δ	+3.8		+0.03	
2nd	270 ± 40	‡296 ± 33	289 ± 38	300 ± 31
%Δ	+9.6		+3.8	
3rd	260 ± 36	‡280 ± 37	276 ± 39	292 ± 33
%Δ	+7.7		+5.8	
4th	251 ± 37	‡277 ± 29	275 ± 41	281 ± 33
%Δ	§+10.3		+2.1	

\*SIT = sprint interval training; CON = control group.

†N = 8 for each group. Data are mean (±SD).

‡Significantly greater than pretraining value ( $p \leq 0.05$ ).

§Significantly different change compared with CON group ( $p \leq 0.05$ ).

# Retorno às atividades

Treino contínuo de moderado  
volume + HIT longo

Sprints repetidos



HIT curto + SIT + sprints  
repetidos

Treino contínuo de baixo volume

Treino de força máxima +  
Treinamento de força  
excêntrica

Treino de potência



Treinamento de força máxima +  
Treinamento de força excêntrica

Treino de potência

MUITO OBRIGADO!



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