10° Συνέδριο Βιοχημείας & Φυσιολογίας της Άσκησης με Διεθνή Συμμετοχή
21-23 Οκτωβρίου 2022
Αθήνα

UNIVERSITY of NICOSIA | DEPARTMENT OF LIFE AND HEALTH SCIENCES

ΠΡΟΣΑΡΜΟΓΗ ΤΗΣ ΔΙΑΛΕΙΜΜΑΤΙΚΗΣ ΑΣΚΗΣΗΣ ΥΨΗΛΗΣ ΕΝΤΑΣΗΣ ΓΙΑ ΤΗΝ ΒΕΛΤΙΣΤΟΠΟΙΗΣΗ ΜΕΤΑΒΟΛΙΚΩΝ, ΚΑΡΔΙΟΑΝΑΠΝΕΥΣΤΙΚΩΝ ΚΑΙ ΨΥΧΟΛΟΓΙΚΩΝ ΑΠΟΚΡΙΣΕΩΝ

Πηνελόπη Σταυρινού, PhD

ΔΙΑΛΕΙΜΜΑΤΙΚΗ ΑΣΚΗΣΗ ΥΨΗΛΗΣ ΕΝΤΑΣΗΣ

IT'S A HIIT!

TABLE 2: Top 20 Worldwide Fitness Trends for 2021

Rank	Top 20 Worldwide Fitness Trends for 2021
1	Online training
2	Wearable technology
3	Body weight training
4	Outdoor activities
5	HIIT
6	Virtual training
7	Exercise is Medicine
8	Strength training with free weights
9	Fitness programs for older adults
10	Personal training
11	Health/wellness coaching
12	Mobile exercise apps
13	Employing certified fitness professionals
14	Functional fitness training

What is HIIT?

J Physiol 600.5 (2022) pp 1013–1026

TOPICAL REVIEW

Low-volume high-intensity interval training for cardiometabolic health

Angelo Sabag[1], Jonathan P. Little[2] and Nathan A. Johnson[3]

High-intensity interval training (HIIT) is characterized by bouts of high-intensity exercise interspersed with active or passive rest periods

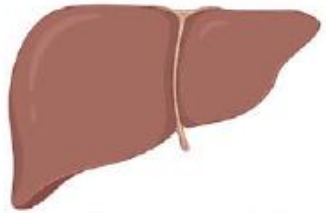
Table 1. Classification of common HIIT variations

	Intensity	Repetitions	Interval Duration	Cumulative Interval Duration*	Work: Rest
Low-volume HIIT	80% to 100% of VO_{2max} or HR_{max}*	1 to 10	60–240s	< 15 min	1:1 to 1:2
High-Volume HIIT	80% to 100% of VO_{2max} or HR_{max}*	≥ 4	60–240s	≥ 15 min	1:1 to 1:2
SIT	> 100% maximal work rate/ VO_{2max}*, 'all out'	≥ 4	8–30s	< 10 min	1:1 to 1:9

Cardiometabolic effects of HIIT

↑ VO2max
↑ Systolic and diastolic function
↓ Aortic stiffness
↓ Systolic blood pressure

↓ Insulin resistance
↑ GLUT 4 content
↑ Mitochondrial content
↑ Oxidative capacity



↑ Insulin sensitivity
↓ Intrahepatic fat
↓ Gluconeogenesis
↓ *de novo* Lipogenesis

Sabag et al., *J Physiol* 2022

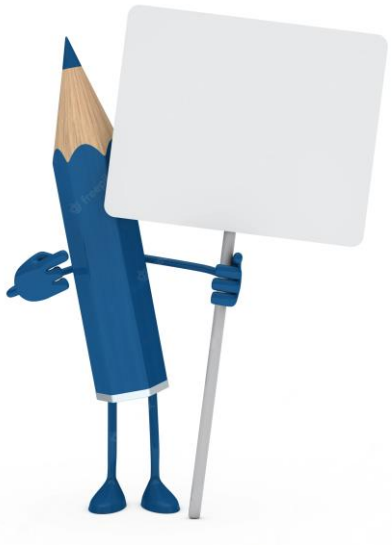
Psychological effects of HIIT

- Improvement in:
  - Quality of life
  - Mental wellbeing
  - Depression severity
  - Perceived stress
  - Anxiety severity
  - Affective responses
  - Exercise enjoyment

EQUAL OR SUPERIOR ADAPTATIONS TO MODERATE-INTENSITY CONTINUOUS TRAINING IN A TIME-EFFICIENT WAY

Martland et al., *JSS* 2020; Stavrinou et al., *APNM* 2019; Stork et al., *HPR* 2017

HOW TO DESIGN A HIIT PROGRAM?



F.I.T.T. principle

FREQUENCY Number of sessions per week

INTENSITY How strenuous is the e

TIME Duration of ex ssion

TYPE Mode ise that is used in the exercise session

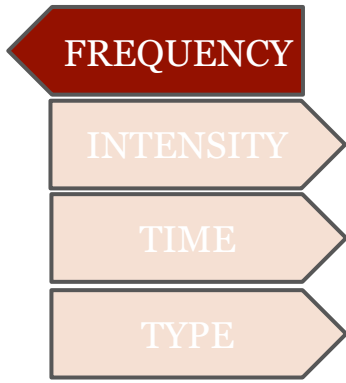
AN OPTIMAL HIIT PROTOCOL REMAINS ELUSIVE

Burnet et al., *Transl Sports Med*. 2020;
Winters-Stone et al., *BJSM* 2013

MANIPULATING F.I.T.T. IN HIIT

FREQUENCY

- The majority of the studies adopted a frequency of **<u>3 sessions per week</u>**
  - Increased VO_2max
  - Improved body composition
  - Increased fat oxidation
  - Improved glucose regulation
  - Increased insulin sensitivity
  - Enjoyment
  - Adherence to exercise



< 3 sessions/week?

Astorino and Schubert, *EJAP* 2018; Little et al., *JAP* 2011; Stavrinou et al., *IJSM* 2018; Stavrinou et al., *APNM* 2019;

Cardiorespiratory fitness

High-intensity Interval Training Frequency: Cardiometabolic Effects and Quality of Life

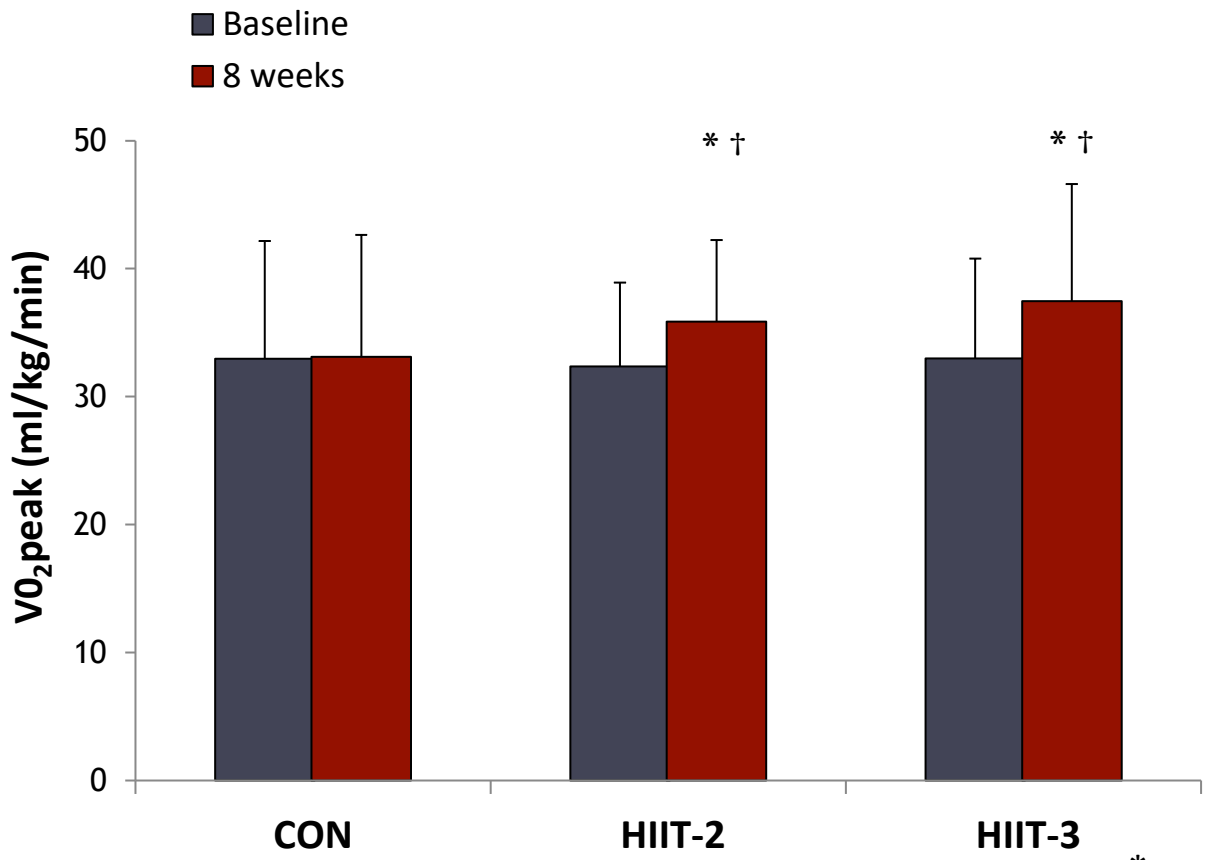
Int J Sports Med 2018; 39(03): 210-217
DOI: 10.1055/s-0043-125074

Pinelopi S. Stavrinou , Gregory C. Bogdanis , Christoforos D. Giannaki , Gerasimos Terzis , Marios Hadjicharalambous

Healthy inactive adults
CON; HIIT-2 (2 HIIT/wk); HIIT-3 (3 HIIT/wk)
HIIT: 10 x 1-min bouts ~83% PPO x 8 wks

HIIT-2 = HIIT-3

↑ 10.8% ↑ 13.6%



* p < 0.01 from baseline ; † p < 0.05 from CON

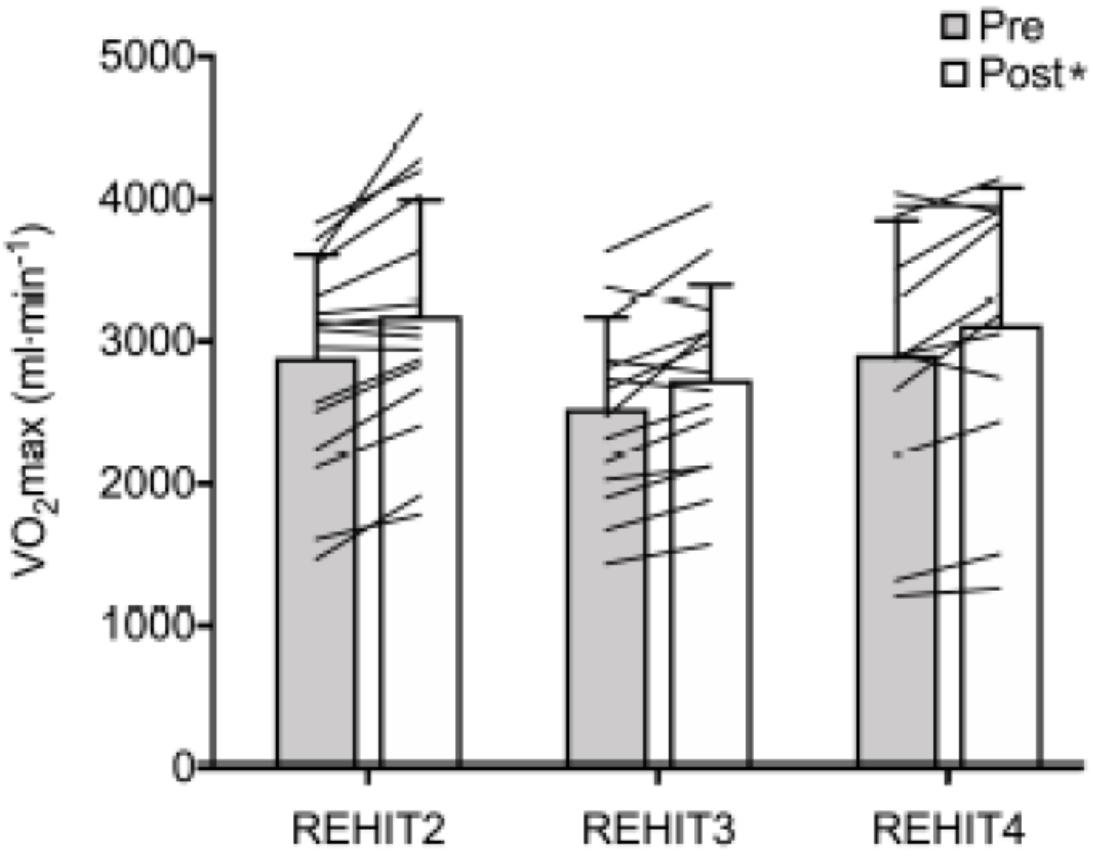
Inactive young individuals
2 vs 3 vs 4 REHIT sessions/wk
REHIT: 2 X 10-20 s all-out sprints x 6 wks

Home / Applied Physiology, Nutrition, and Metabolism / Volume 45, Number 6, June 2020 / Reducing training frequency fro...

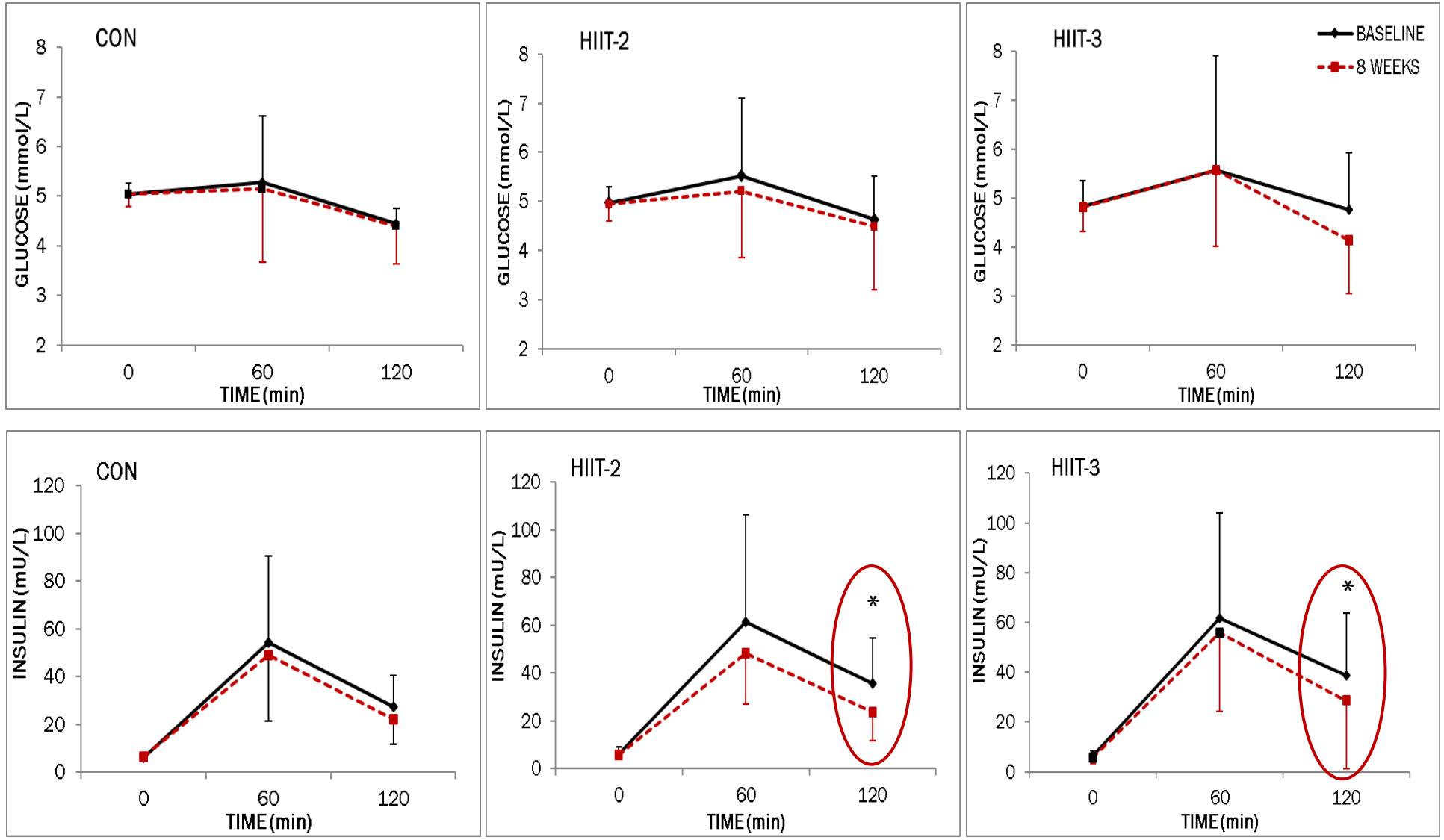
Brief Communication

Reducing training frequency from 3 or 4 sessions/week to 2 sessions/week does not attenuate improvements in maximal aerobic capacity with reduced-exertion high-intensity interval training (REHIT)

Authors: Gavin Thomas, Preeyaphorn Songsorn, Aimee Gorman, Ben Brackenridge, Tom Cullen, Ben Fitzpatrick, Richard S. Metcalfe, and Niels B.J. Vollaard | AUTHORS INFO & AFFILIATIONS



Metabolic adaptations - Glucose regulation

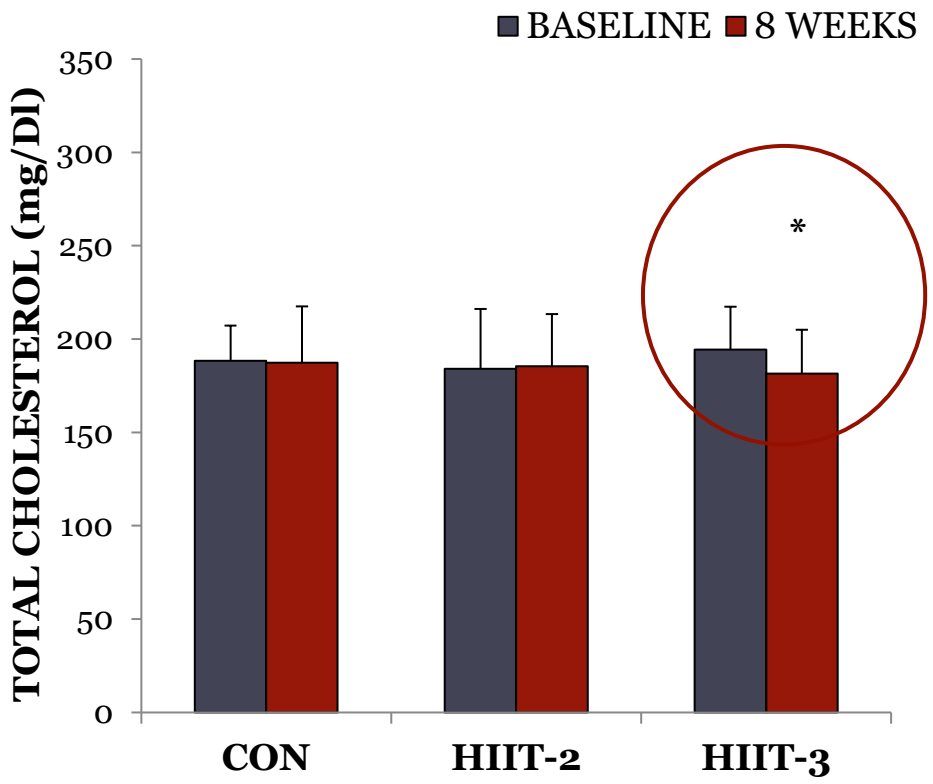


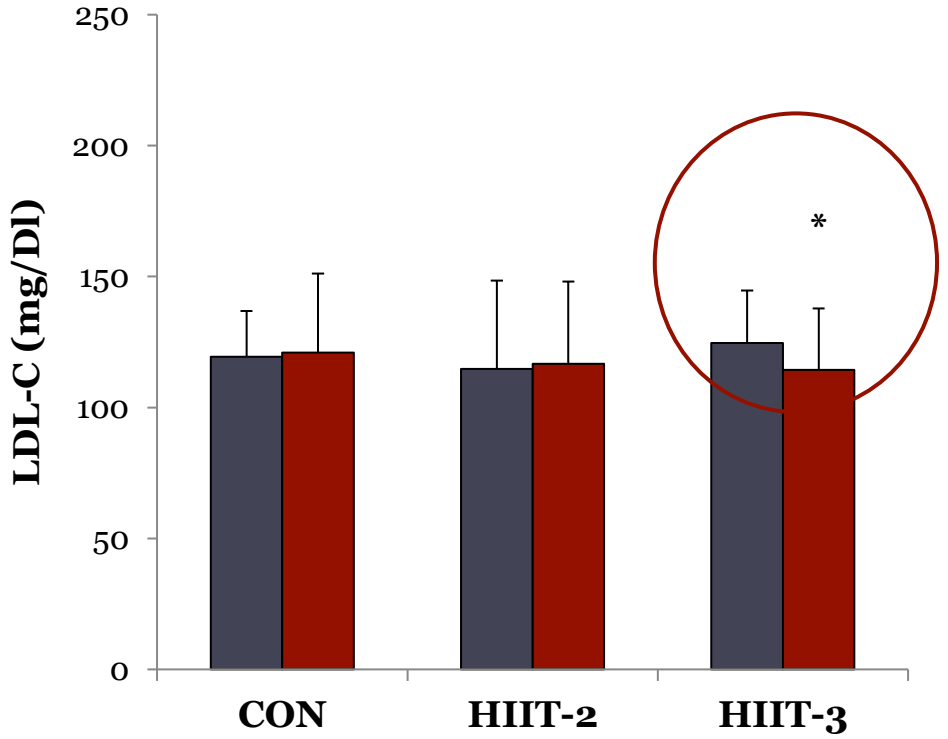
Pinelopi Stavrinou, PhD

* $p < 0.05$ from baseline

Stavrinou et al. *IJSM* 2018

Lipid profile





No change in HDL-C and TG

Stavrinou et al., *IJSM* 2018

* $p < 0.05$ from baseline

Body composition

Variable	CON		HIIT-2		HIIT-3	
	Baseline	8 weeks	Baseline	8 weeks	Baseline	8 weeks
Weight (kg)	67.4 ± 12.2	67.4 ± 13.1	66.5 ± 18.9	66.1 ± 18.5	69.6 ± 17.6	69.2 ± 17.3
BMI ($kg \cdot m^{-2}$)	23.4 ± 3.1	23.4 ± 3.4	23.6 ± 4.6	23.4 ± 4.4	24.1 ± 4.2	24.0 ± 4.1
%Body Fat	16.6 ± 6.7	17.1 ± 6.9	18.8 ± 5.7	19.0 ± 6.2	17.0 ± 5.4	16.3 ± 5.0 * †#
Waist circumference (cm)	88.8 ± 8.7	88.5 ± 8.9	89.9 ± 12.6	88.4 ± 12.6 * †	90.2 ± 12.3	87.9 ± 12.0 * * †
%Trunk fat	25.5 ± 7.3	25.4 ± 7.6	28.3 ± 7.2	27.0 ± 7.9	26.1 ± 8.9	24.2 ± 8.8 * * †

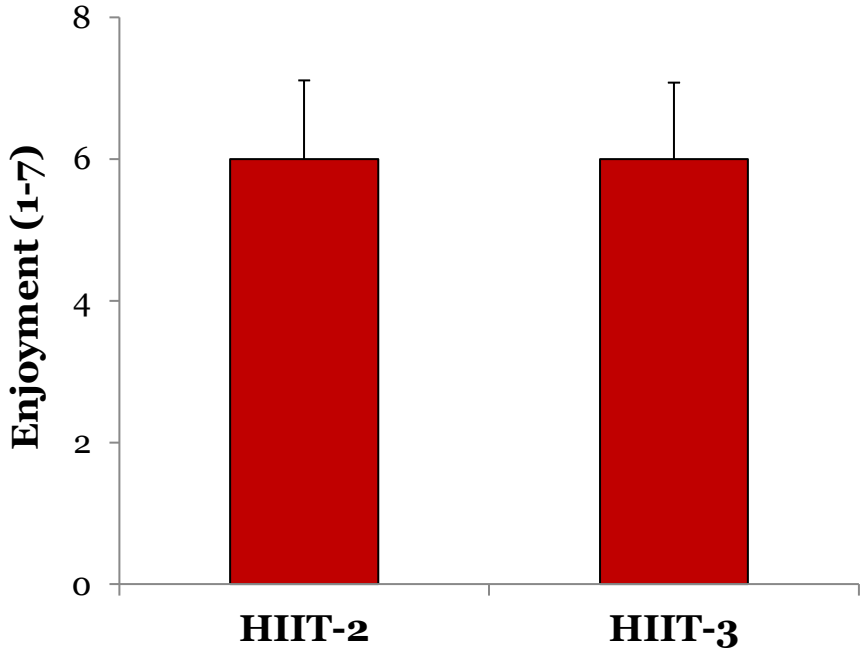
Stavrinou et al., *IJSM* 2018

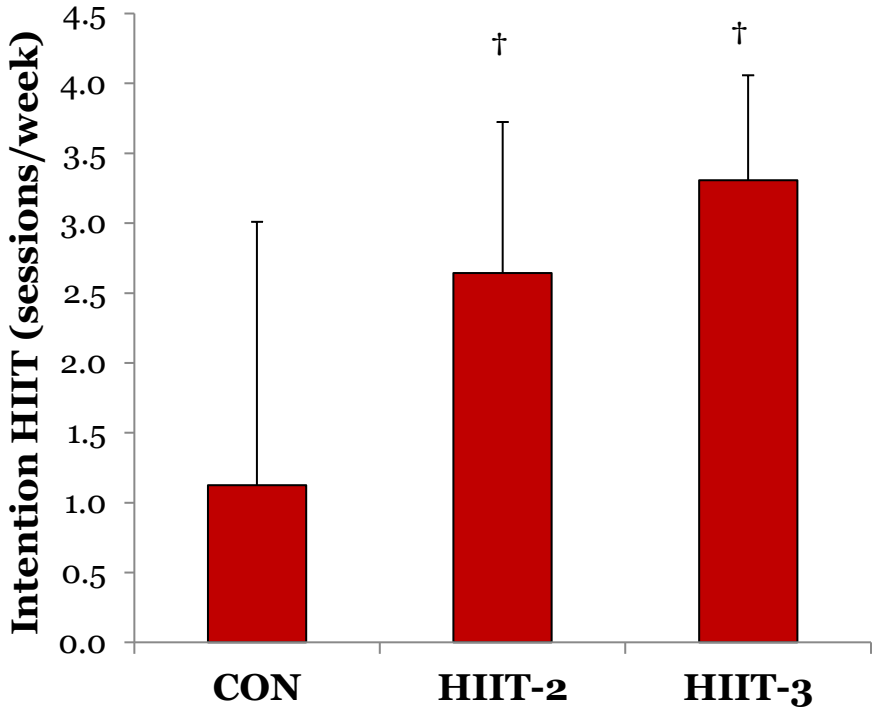
Effects of high-intensity interval training frequency on perceptual responses and future physical activity participation

Pinelopi S. Stavrinou, Gregory C. Bogdanis, Christoforos D. Giannaki, Gerasimos Terzis, and Marios Hadjicharalambous

Appl. Physiol. Nutr. Metab. 44: 952–957 (2019)

Perceptual responses





† $p < 0.05$ from CON

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PA following HIIT

	CON		HIIT-2		HIIT-3	
Variable	Pre	Follow-up	Pre	Follow-up	Pre	Follow-up
Vigorous PA (MET-min·wk⁻¹)	0±0	0±0	0±0	371±559*	0±0	862±709†,§
Moderate PA (MET-min·wk⁻¹)	125±173	120±143	194±156	399±309*	225±204	251±318
Walking (MET-min·wk⁻¹)	124±235	186±353	154±146	242±136	123±110	194±163
Total PA (MET-min·wk⁻¹)	249±223	306±358	349±165	1012±505†	348±219	1307±871†,‡
Sitting time (min·d⁻¹)	360±203	368±196	444±270	411±251	402±179	318±177
PA category (%)						
Low	100	87.5	100	35.7	100	23.1
Moderate	0	12.5	0	57.1	0	53.8
High	0	0	0	7.1	0	23.1

Stavrinou et al., *APNM* 2019

Conclusions for manipulating HIIT frequency

Performing <3 HIIT sessions/week:

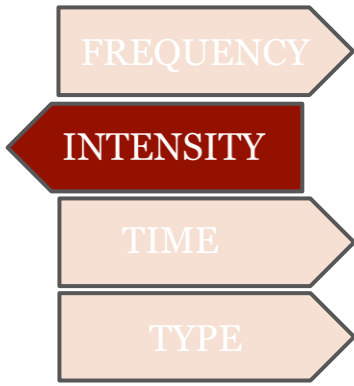
+ Positive adaptations of the cardiorespiratory system
+ Improved glucose regulation (>2 sessions)
+ Enjoyable and may promote future adherence to physical activity
– No effect on blood lipid profile
– No effect on body composition

Further research is needed

INTENSITY - SIT Vs HIIT

- Both HIIT and SIT can:
  - Increase cardiorespiratory fitness
  - Reduce total, abdominal and visceral fat mass
  - Reduce postprandial glucose AUC
  - Improve fat oxidation
  - Improve mental health
  - Be enjoyable

EQUALLY?



Atakan et al., 2022; de Oliveira Nunes et al., 2021; Khalafi et al., 2022; Maillard et al., 2018; Sloth et al., 2013

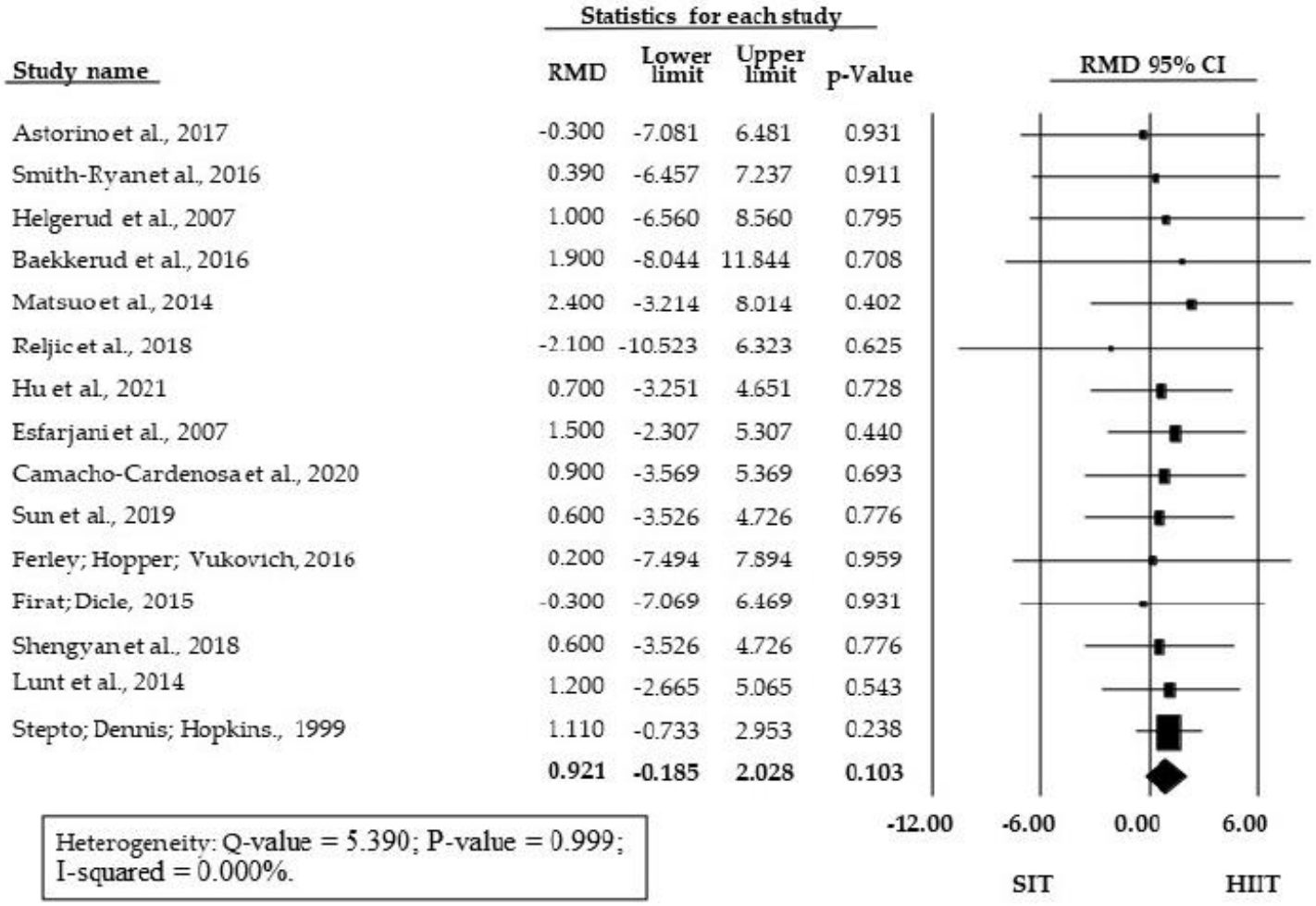
Cardiorespiratory fitness

Review

HIIT vs. SIT: What Is the Better to Improve $\dot{V}O_2$max? A Systematic Review and Meta-Analysis

Silas Gabriel de Oliveira-Nunes [1,*], Alex Castro [1,2,*], Amanda Veiga Sardeli [1,*], Claudia Regina Cavaglieri [1] and Mara Patricia Traina Chacon-Mikahil [1]

Int. J. Environ. Res. Public Health 2021, *18*, 13120



Study name	RMD	Lower limit	Upper limit	p-Value
Astorino et al., 2017	-0.300	-7.081	6.481	0.931
Smith-Ryan et al., 2016	0.390	-6.457	7.237	0.911
Helgerud et al., 2007	1.000	-6.560	8.560	0.795
Baekkerud et al., 2016	1.900	-8.044	11.844	0.708
Matsuo et al., 2014	2.400	-3.214	8.014	0.402
Reljic et al., 2018	-2.100	-10.523	6.323	0.625
Hu et al., 2021	0.700	-3.251	4.651	0.728
Esfarjani et al., 2007	1.500	-2.307	5.307	0.440
Camacho-Cardenosa et al., 2020	0.900	-3.569	5.369	0.693
Sun et al., 2019	0.600	-3.526	4.726	0.776
Ferley; Hopper; Vukovich, 2016	0.200	-7.494	7.894	0.959
Firat; Dicle, 2015	-0.300	-7.069	6.469	0.931
Shengyan et al., 2018	0.600	-3.526	4.726	0.776
Lunt et al., 2014	1.200	-2.665	5.065	0.543
Stepto; Dennis; Hopkins., 1999	1.110	-0.733	2.953	0.238
	0.921	**-0.185**	**2.028**	**0.103**

Heterogeneity: Q-value = 5.390; P-value = 0.999; I-squared = 0.000%.

HIIT and SIT protocols promote similar gains (8-15%) in cardiorespiratory fitness
Which are
Greater in inactive individuals (15%)

JOURNAL OF SPORTS SCIENCES
2019, VOL. 37, NO. 11, 1257–1264
https://doi.org/10.1080/02640414.2018.1554615

Routledge
Taylor & Francis Group

PHYSICAL ACTIVITY, HEALTH AND EXERCISE

Metabolic adaptations

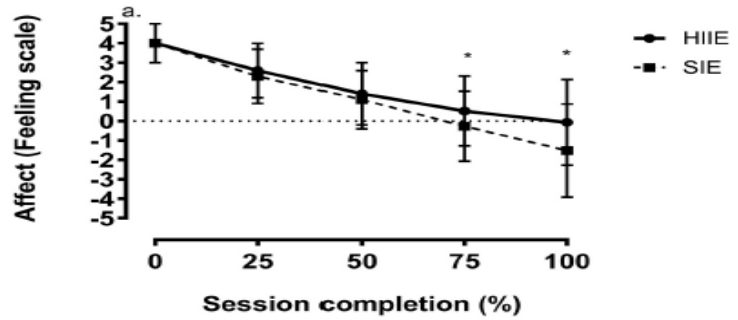
Overweight young women
SIT (80 × 6-s sprints, 9s rest)
HIIT (9 × 4-min cycling at 90% V̇O2peak, 3min rest)
MICT (cycling at 60% V̇ O2peak for ~ 61-min)
3 d/week, 12 weeks

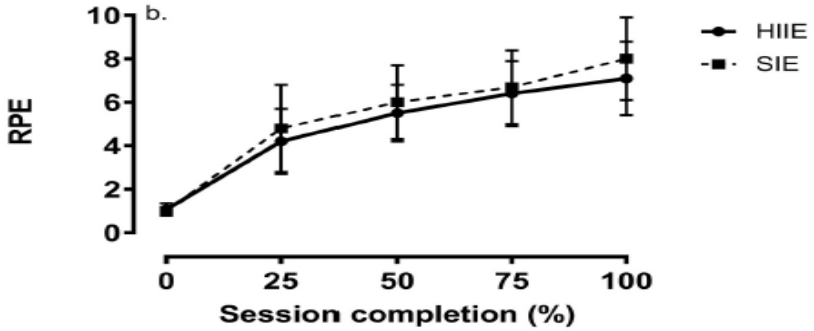
Twelve weeks of low volume sprint interval training improves cardio-metabolic health outcomes in overweight females

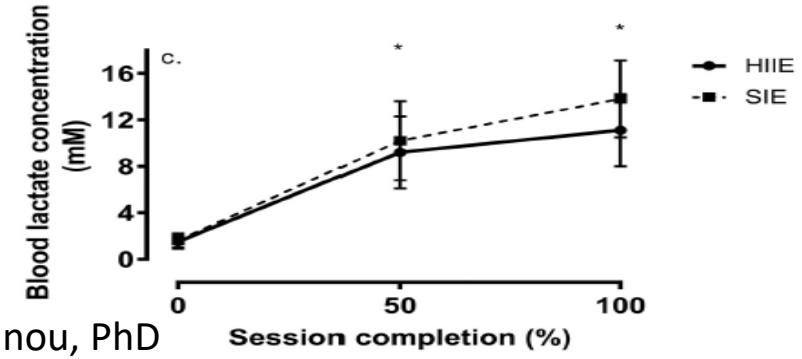
Shengyan Sun[a,b], Haifeng Zhang[c], Zhaowei Kong [a], Qingde Shi[d], Tomas K. Tong[e] and Jinlei Nie [d]

	SIT (n=14)		HIIT (n=14)		MICT (n=14)		Time effect		Interaction effect	
	Pre	Post	Pre	Post	Pre	Post	p	η^2	p	η^2
Age (y)	21.4 ± 1.1		21.5 ± 1.8		20.9 ± 1.4					
Insulin (μIU·mL^{-1})	4.00 ± 1.22	2.87 ± 1.43*	6.01 ± 1.84	3.59 ± 3.05*	4.52 ± 2.44	4.17 ± 3.98	<0.001	0.322	0.027	0.170

Metabolic-perceptual responses





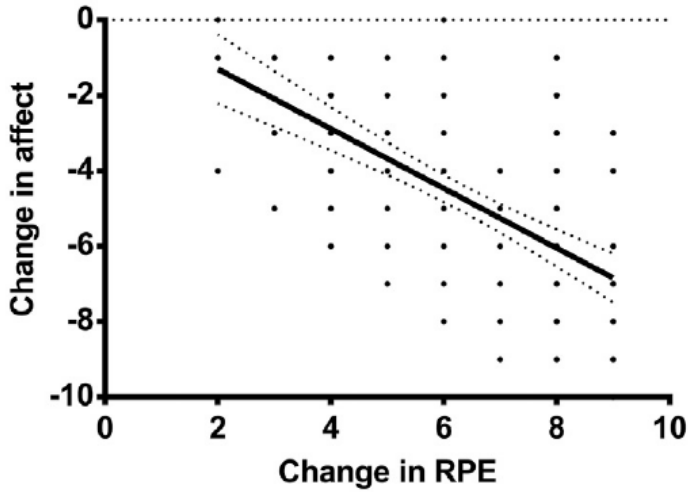


Predictors of change in affect in response to high intensity interval exercise (HIIE) and sprint interval exercise (SIE)

Todd A. Astorino[a,*], Chantal A. Vella[b]

Physiology & Behavior 196 (2018) 211–217

Active men and women
Various HIIE and SIE regimes
Cycle ergometer



Conclusions for manipulating HIIT intensity

- Performing either HIIT or SIT may promote:
  - Similar cardiorespiratory adaptations
  - Higher blood lactate but possibly similar metabolic adaptations

- However, compared to HIIT, SIT may induce:
  - More aversive responses
  - Higher levels of perceived fatigue

Bout duration

Young healthy recreationally active males
Total duration 20min
HIIE Exercise:recovery ratio = 1:1.5

APPLIED SCIENCE

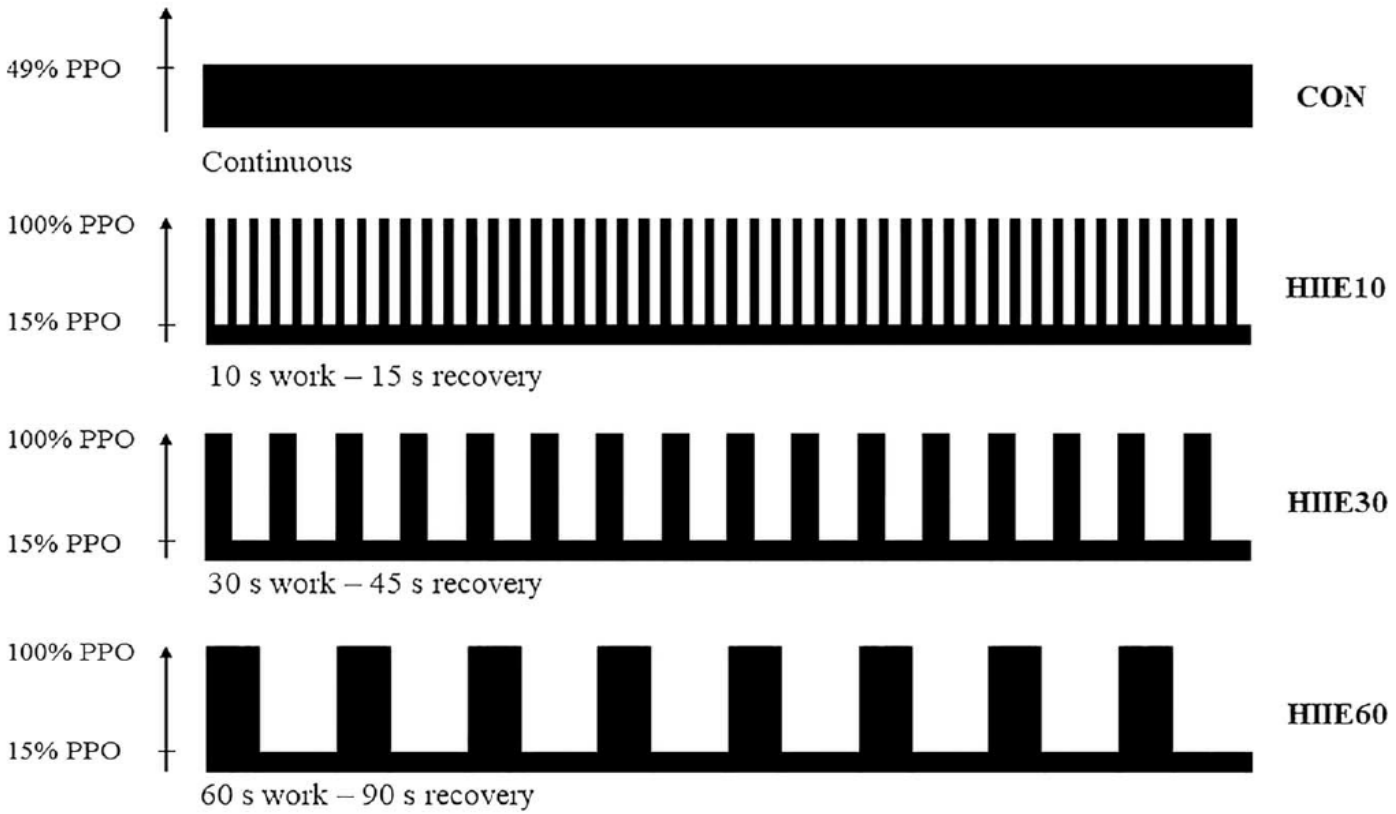
Attenuated Metabolic and Cardiorespiratory Responses to Isoenergetic High-Intensity Interval Exercise of Short Versus Long Bouts

BOGDANIS, GREGORY C.[1]; STAVRINOU, PINELOPI S.[2]; TSIRIGKAKIS, SPYRIDON[3]; MOUGIOS, VASSILIS[4]; ASTORINO, TODD A.[5]; MASTORAKOS, GEORGE[6,7]

Author Information

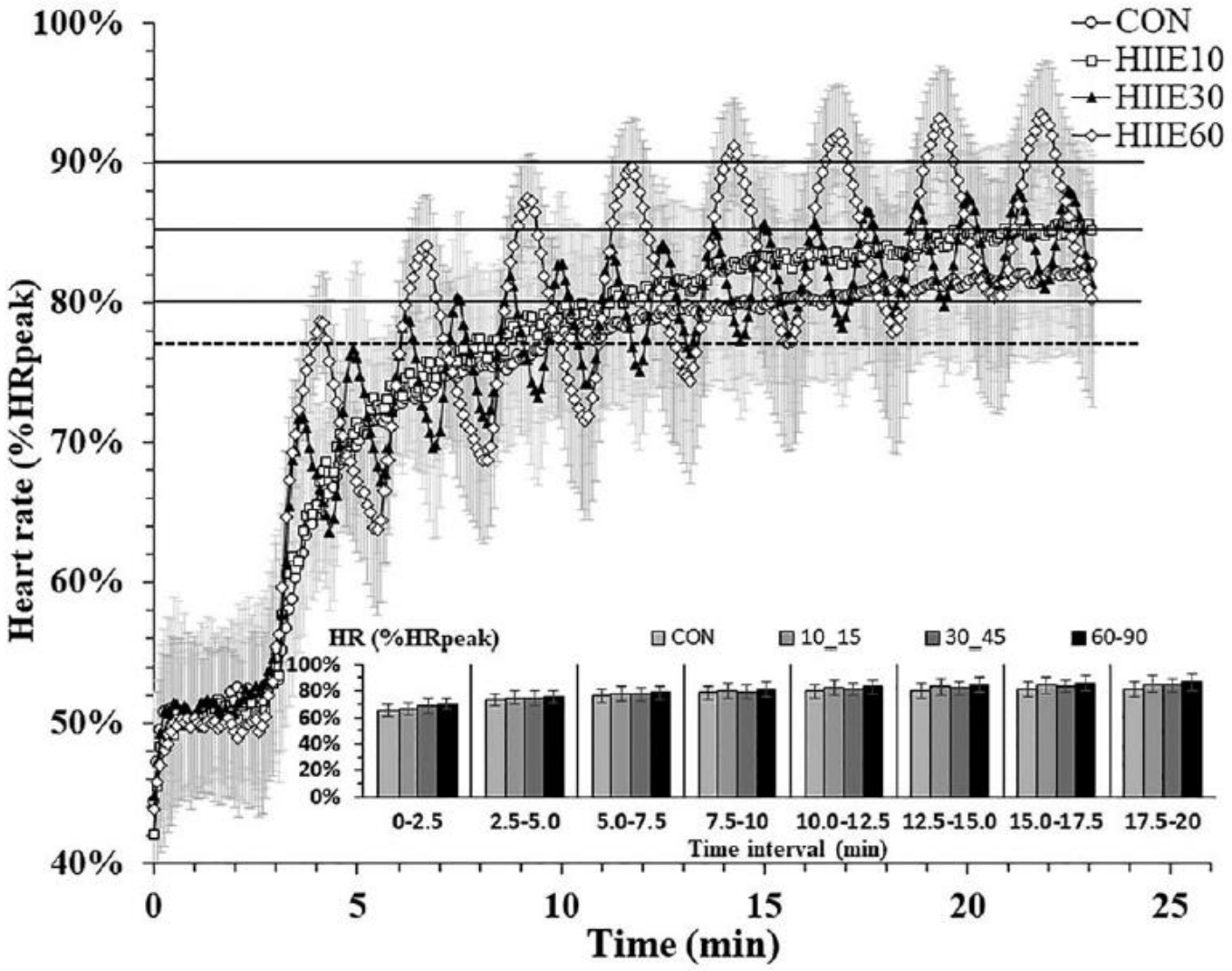
Medicine & Science in Sports & Exercise: July 2022 - Volume 54 - Issue 7 - p 1199-1209
doi: 10.1249/MSS.0000000000002905

FREQUENCY
INTENSITY
TIME
TYPE



Equal total work

Cardiorespiratory responses



VO_2mean and HRmean

No difference between the 3 HIIE

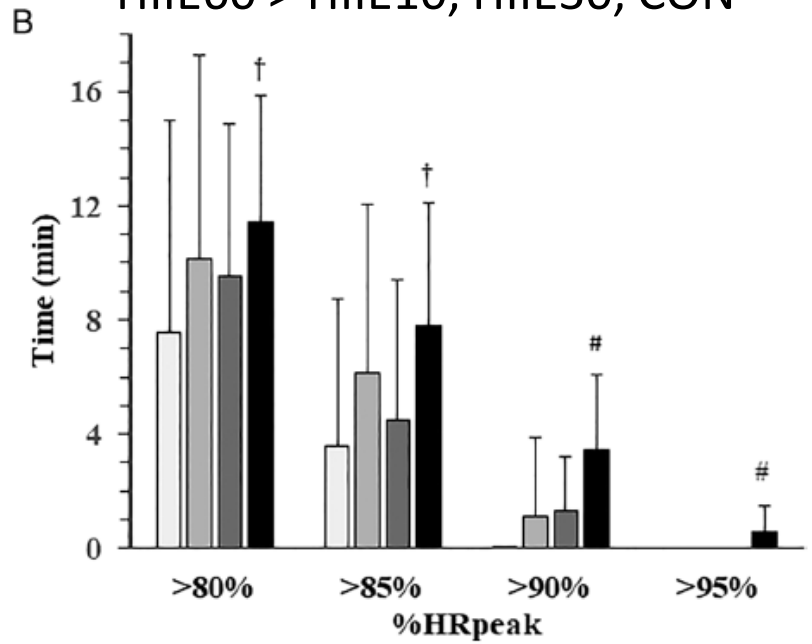
All HIIE > CON

VO_2peak andHRpeak

HIIE60 > HIIE10, HIIE30, CON

VO_2 and HR oscillations

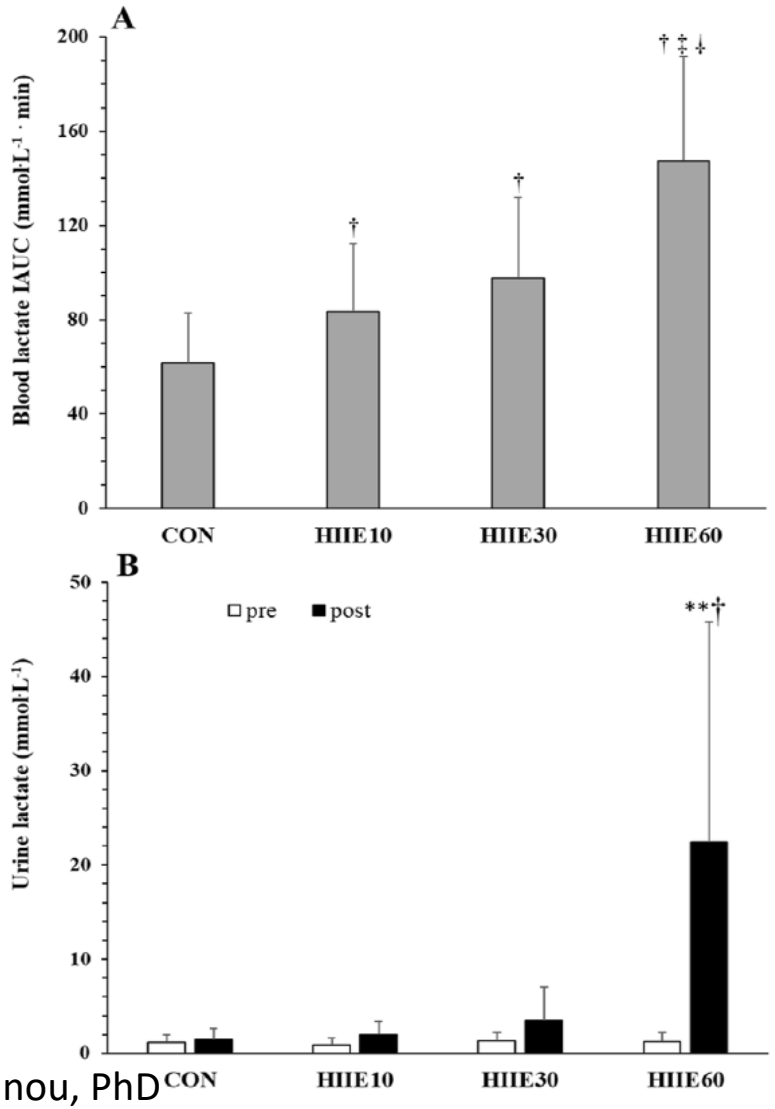
HIIE60 > HIIE10, HIIE30, CON



Pinelopi Stavrinou, PhD

Bogdanis et al., *MSSE* 2022

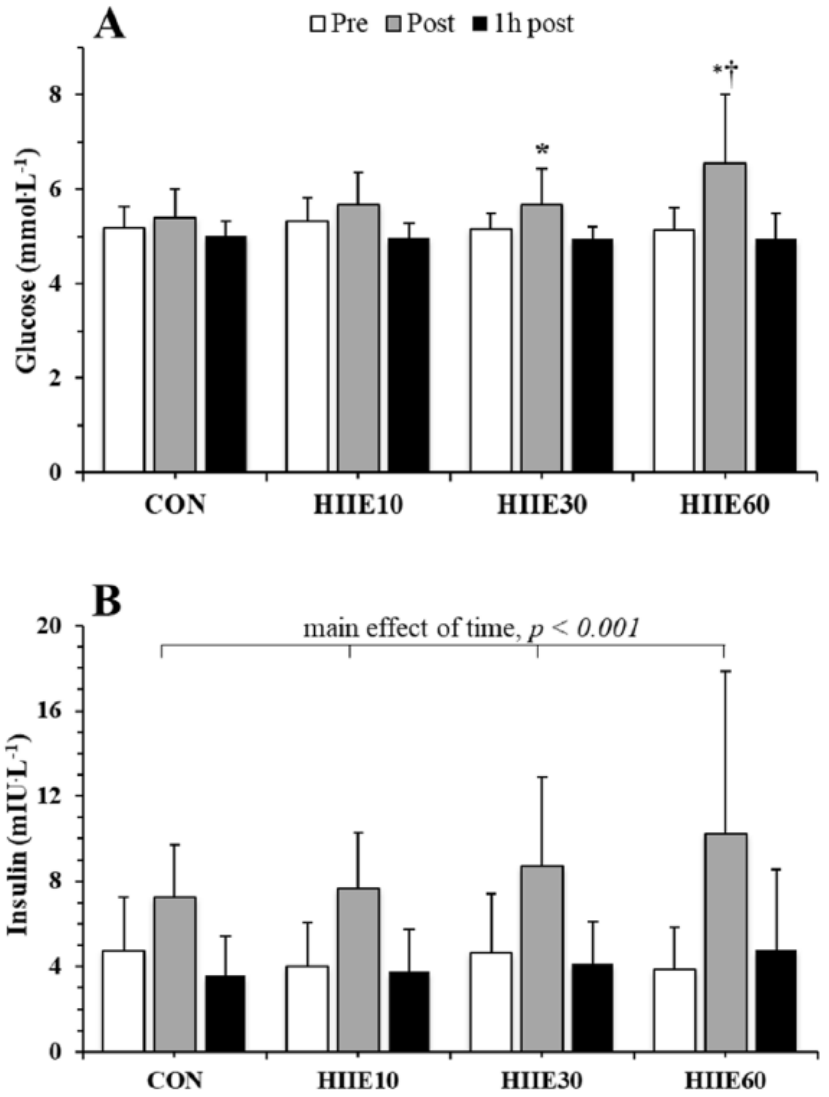
Metabolic responses



Bout duration in high-intensity interval exercise modifies hematologic, metabolic and antioxidant responses

Gregory C. Bogdanis [a, *], George Mastorakos [b, c], Spyridon Tsirigkakis [d], Pinelopi S. Stavrinou [e], Athanasios Kabasakalis [f], Aimilia Mantzou [g], Vassilis Mougios [f]

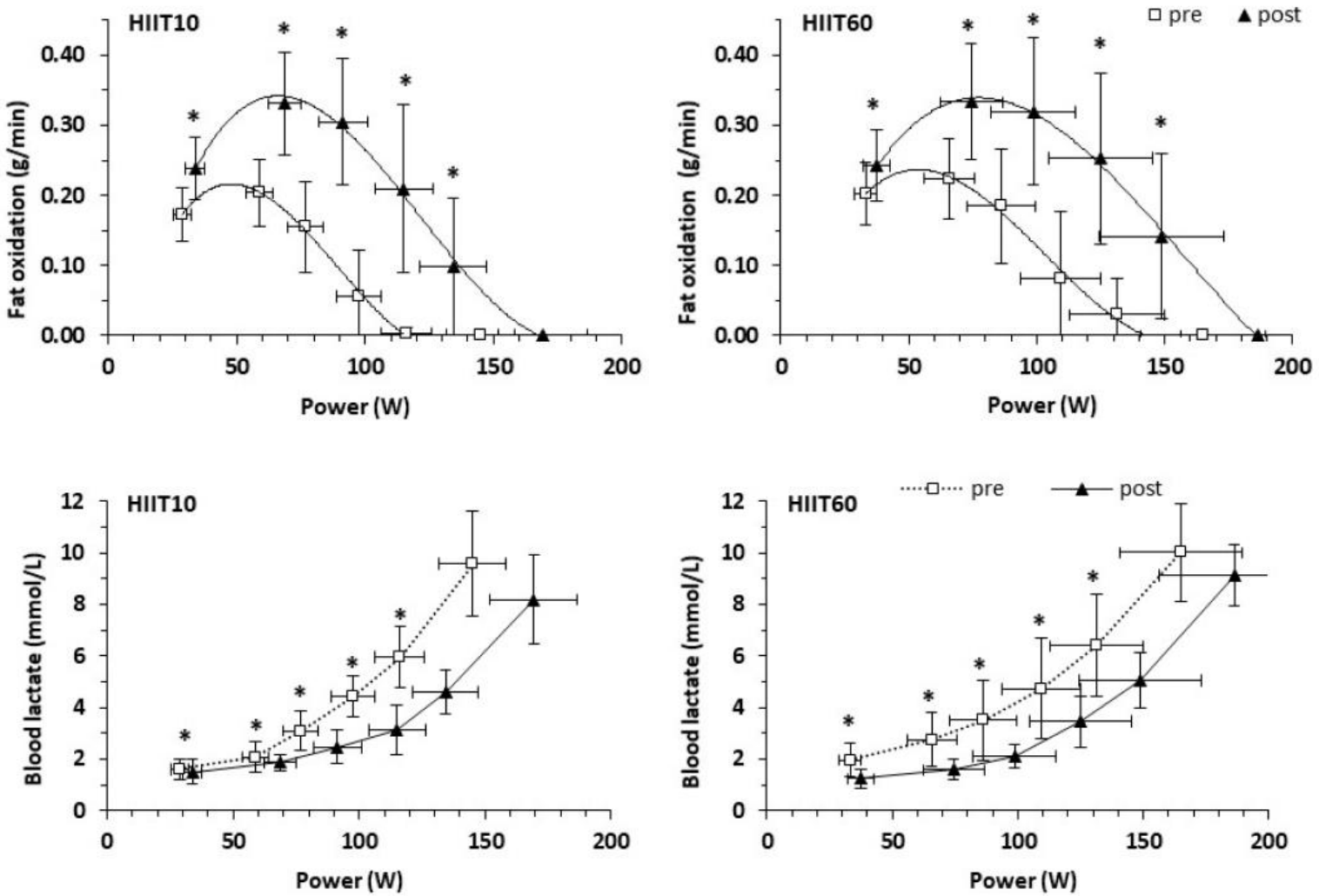
Journal of Exercise Science & Fitness 20 (2022) 216–223



Metabolic responses

Effects of Two Workload-Matched High-Intensity Interval Training Protocols on Regional Body Composition and Fat Oxidation in Obese Men

Spyridon Tsirigkakis [1], George Mastorakos [2], Yiannis Koutedakis [1,3], Vassilis Mougios [4], Alan M. Nevill [3], Zoe Pafili [5] and Gregory C. Bogdanis [6,*]



Body composition

HIIT 10 s vs. HIIT 60s

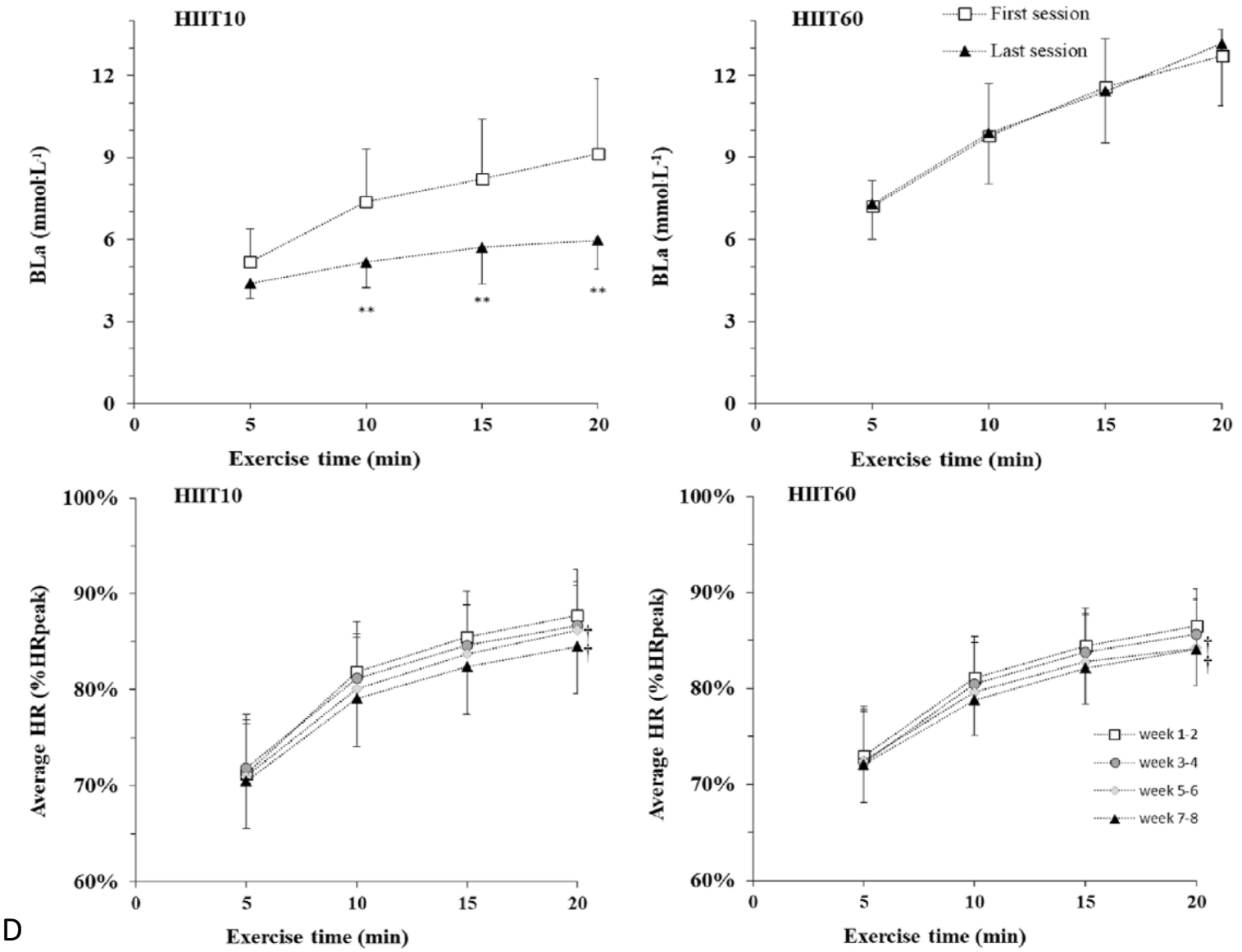
	Pre vs. Post
	Change (90 CI%); Hedges g
Body mass (kg)	−1.12 (−1.88, −0.35), ES = 0.09
Total fat mass (kg)	−1.81 (−2.63, −0.99), ES = 0.32
Trunk fat mass (kg)	−1.45 (−1.95, −0.94), ES = 0.46
Lean body mass (kg)	0.82 (0.59, 1.05), ES = 0.10
Leg lean mass (kg)	0.86 (0.63, 1.08), ES = 0.35

Tsirigkakis et al., *Nutrients* 2021

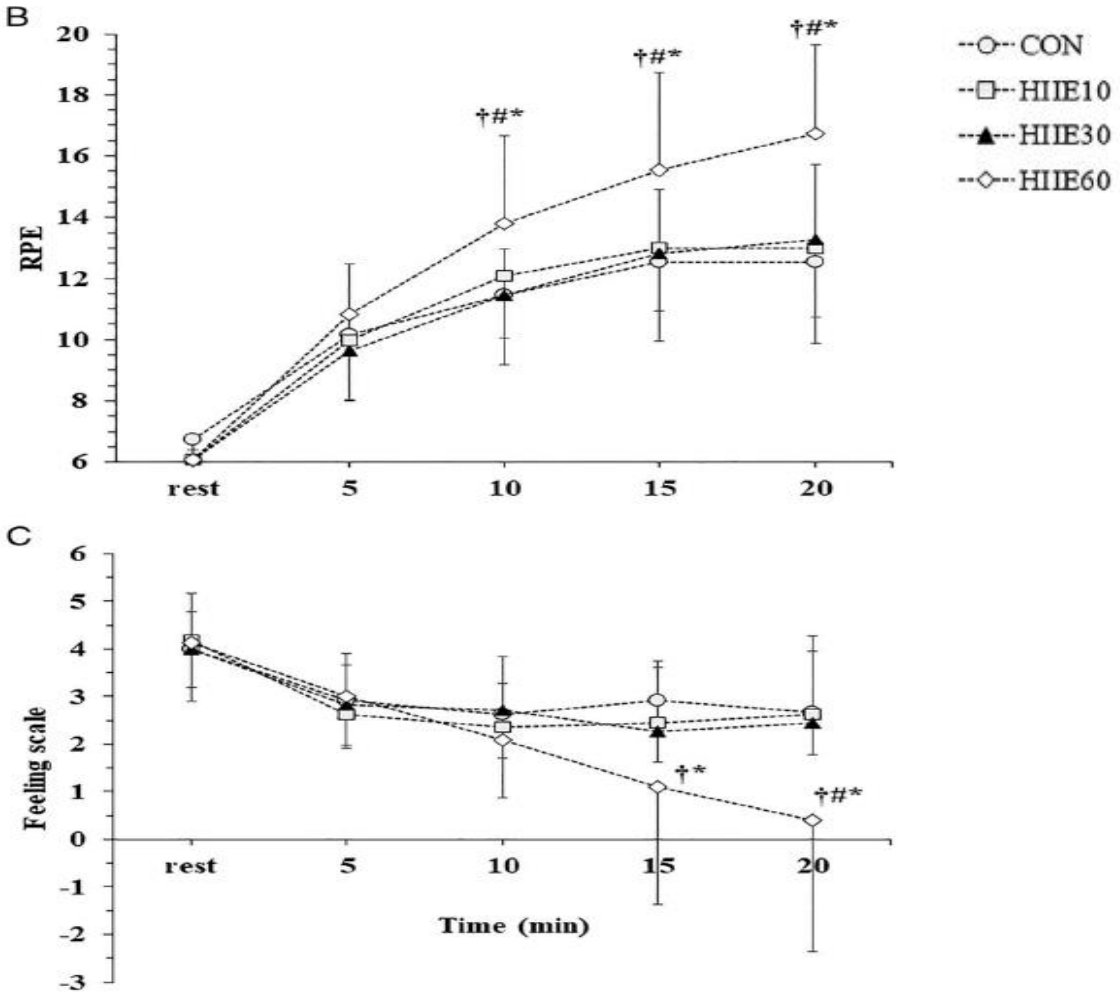
Metabolic responses

Physiological, perceptual and affective responses to high-intensity interval training using two work-matched programs with different bout duration in obese males Journal of Exercise Science & Fitness 20 (2022) 199–205

Spyridon Tsirigkakis [a], Yiannis Koutedakis [a], George Mastorakos [b, c], Pinelopi S. Stavrinou [d], Vassilis Mougios [e], Gregory C. Bogdanis [f, *]

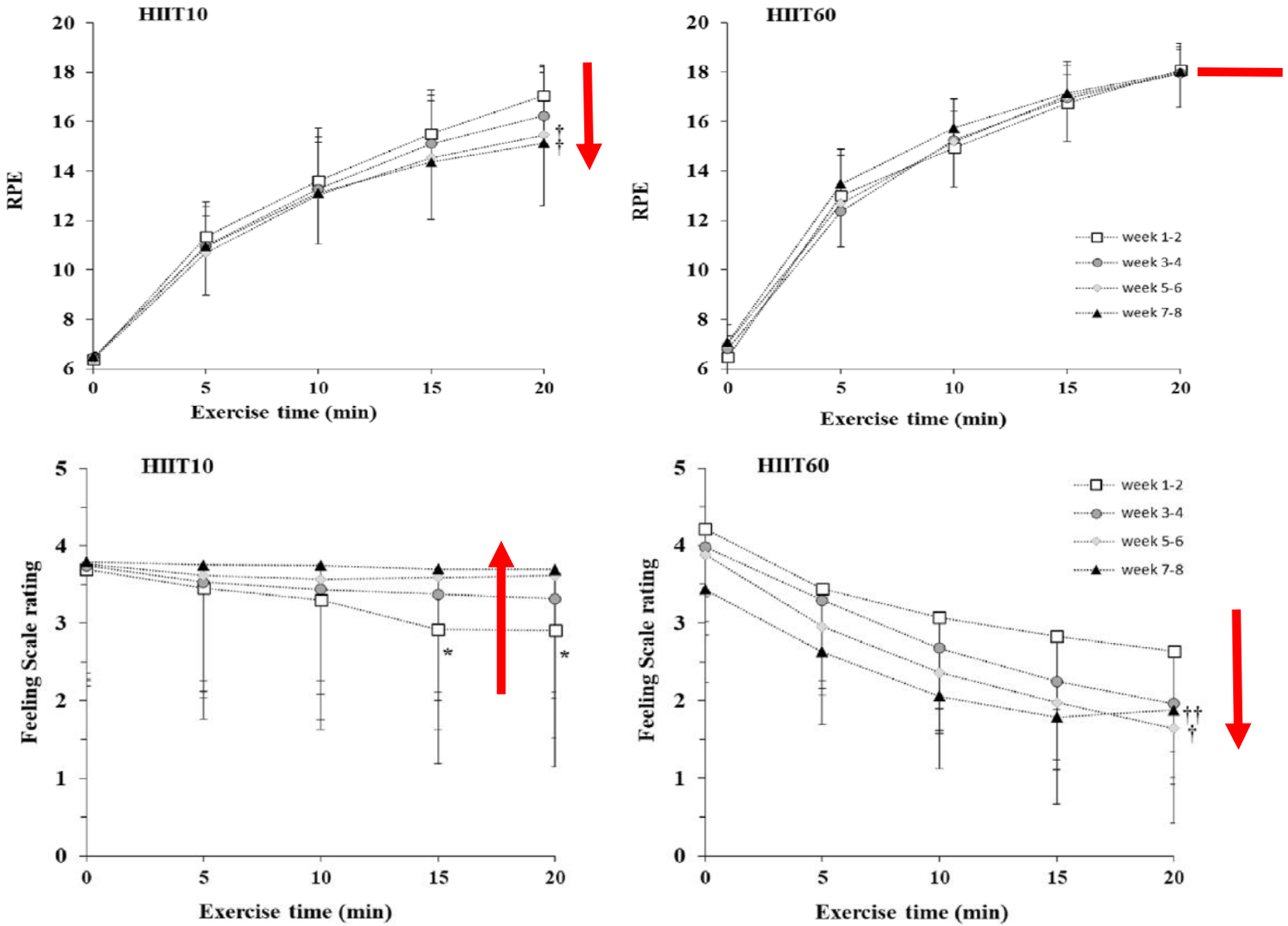


Perceptual responses



Bogdanis et al., *MSSE* 2022

Perceptual responses



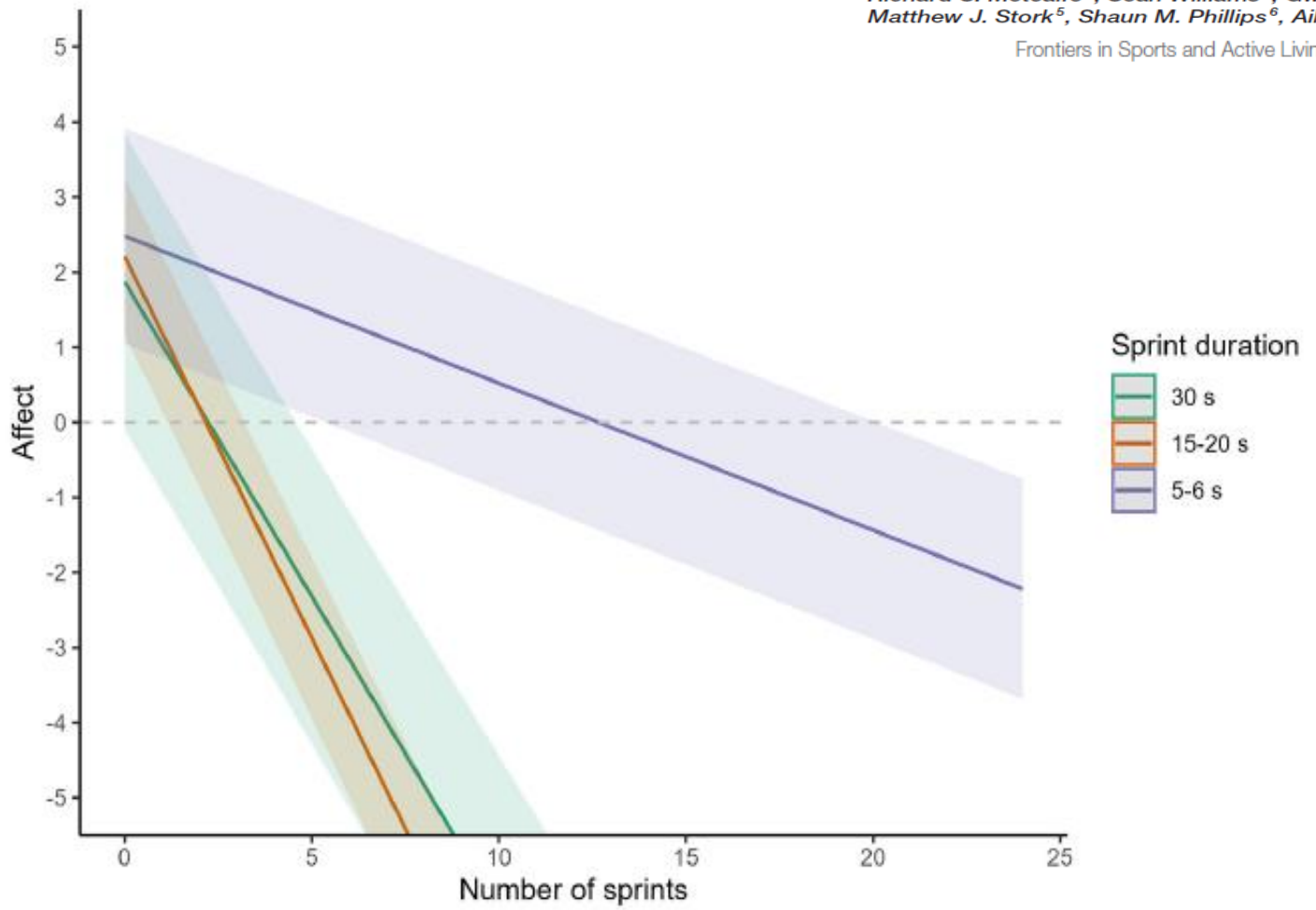
Tsirigkakis et al., *JESF* 2022

Perceptual responses

Affecting Effects on Affect: The Impact of Protocol Permutations on Affective Responses to Sprint Interval Exercise; A Systematic Review and Meta-Analysis of Pooled Individual Participant Data

*Richard S. Metcalfe[1], Sean Williams[2], Gwen S. Fernandes[3], Todd A. Astorino[4], Matthew J. Stork[5], Shaun M. Phillips[6], Ailsa Niven[7] and Niels B. J. Vollaard[8]**

Frontiers in Sports and Active Living | February 2022 | Volume 4 | Article 815555



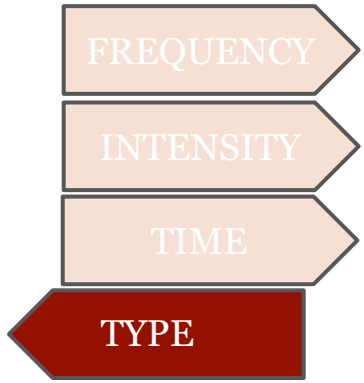
Conclusions for manipulating HIIT time

- Shorter bouts compared to longer (when total work is equal) may induce:
  - Attenuated cardiorespiratory responses
  - Less metabolic strain
  - Lower RPE
  - Less adverse affective responses

HIIT TYPES

- Running
- Leg cycling
- Arm cycling
- Rowing
- Elliptical
- Stair climbing

Increases in various cardiorespiratory and metabolic parameters



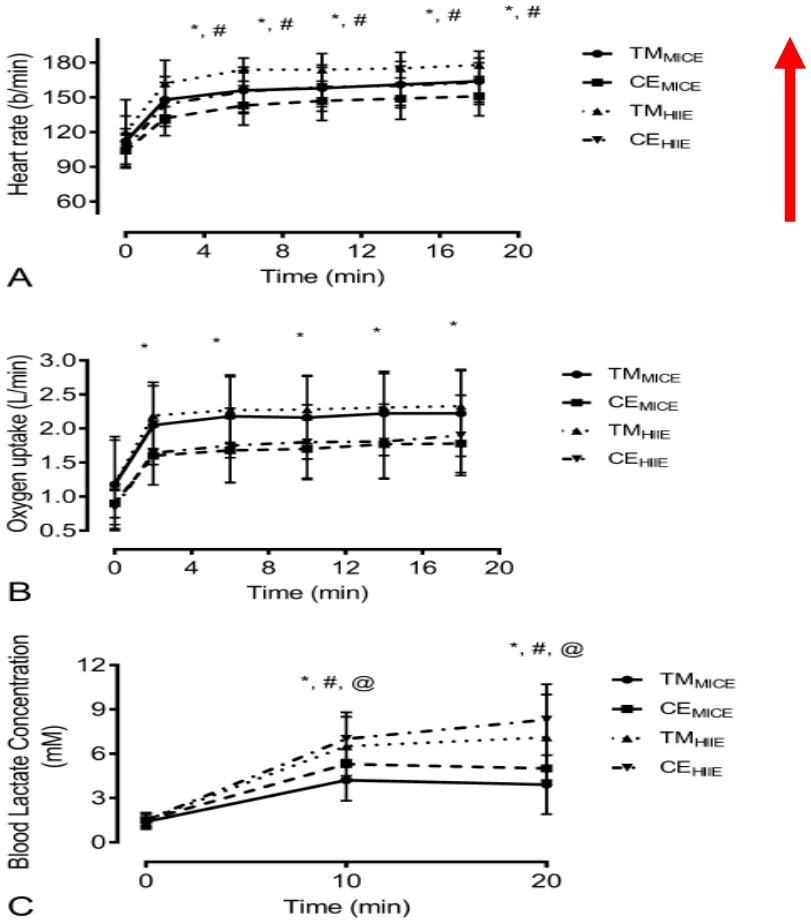
Allison et al., 2017; Astorino et al., 2021, 2022; Bartlett et al., 2012; Fex et al., 2014; Stavrinou et al., 2018

Running Vs Cycling HIIT

PARAMETER	HIIT
Reduction in visceral fat mass (Maillard et al., 2018)	Running > Cycling
Reduction in body mass (Wewege et al., 2017)	Running > Cycling
Reduction in body fat mass (Wewege et al., 2017, Maillard et al., 2018)	Running > Cycling
Reduction in abdominal fat mass (Maillard et al., 2018)	Running < Cycling
Injuries/orthopedic problems (Reljic et al., 2019)	Running > Cycling
Dropout rates (Reljic et al., 2019)	Running > Cycling
Mental health gains (Martland et al., 2022)	Running = Cycling

Running Vs Cycling HIIT

Active adults
10x1-min efforts at 20% above VT, 1 min active recovery



Effects of Exercise Structure and Modality on Physiological and Perceptual Responses to Exercise

Gregory C. Bogdanis,[1] Vasiliki J. Mallios,[1] Christos Katsikas,[1] Theodora Fouseki,[1] Iain Holman,[2] Caitlin Smith,[2] and Todd A. Astorino[2]

J Strength Cond Res 35(9): 2427–2432, 2021-

RUNNING: **HIGHER HR AND VO2**
CYCLING: **HIGHER LACTATE**
SIMILAR RPE

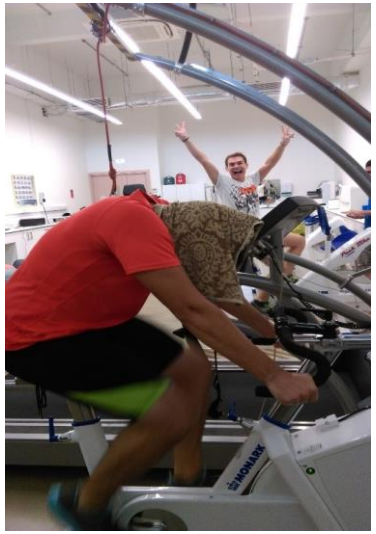
Conclusions for manipulating HIIT type

- HIIT running may be superior to cycling for cardiorespiratory and metabolic adaptations
- Possibly similar feelings of pleasure are induced
- However running could be unsuitable for some populations due to increased impact load, resulting in more injuries and higher dropout rates

NOT ALL HIIT IS OR FEELS THE SAME

WHICH IS THE OPTIMAL HIIT PROTOCOL???

OPTIMAL FOR WHOM???



Pinelopi Stavrinou, PhD

Factors affecting HIIT prescription

- Age
- Fitness status
- Health problems
- Time availability
- Aim
- Equipment
- Motivation

CUSTOMIZE HIIT

Take home message

One HIIT Does Not FITT All

JUST KEEP HIITing IT!

THANK YOU!

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