High Intensity Interval Training (HIIT)

Allenamento intervallato ad alta intensità

Outline

- Premessa: Worldwide Survey of Fitness Trends for 2018
- Razionale
- Principi di prescrizione di HIIT
- Scelta del protocollo (ottimale?)
- Raccomandazioni pratiche

Premessa

- Fitness Trends for 2018

Thompson WR, ACSM's Health & Fitness Journal, 2017

Che cos'è HIIT?

- HIIT è un tipo di allenamento:
  - Svolto ad intensità elevate (RPE > 8/10) or ≥90% VO2max
  - Di breve durata: da 30sec (o meno), a 5 min
  - Seguiti da brevi (durata variabile in funzione del livello di fitness) periodi di recupero a bassa intensità.
  - Recupero "incompleto". La durata e l'intensità del recupero sono variabili in funzione degli obiettivi.
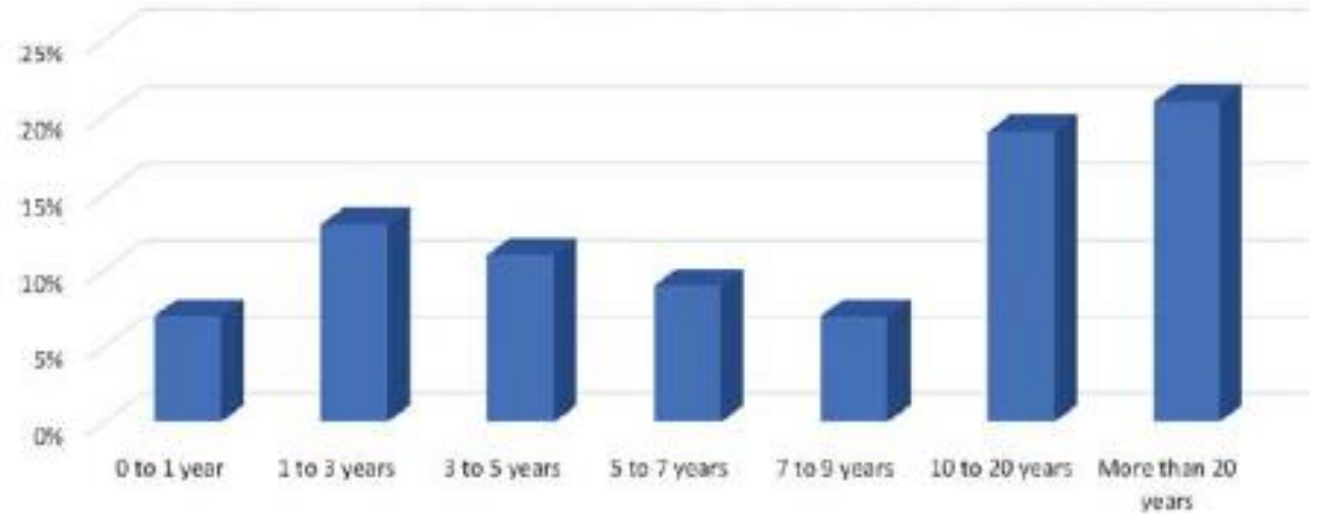
WORLDWIDE SURVEY OF FITNESS TRENDS FOR 2018

Figure 1. Age (in years) of survey respondents.

Thompson WR, ACSM's Health & Fitness Journal, 2017
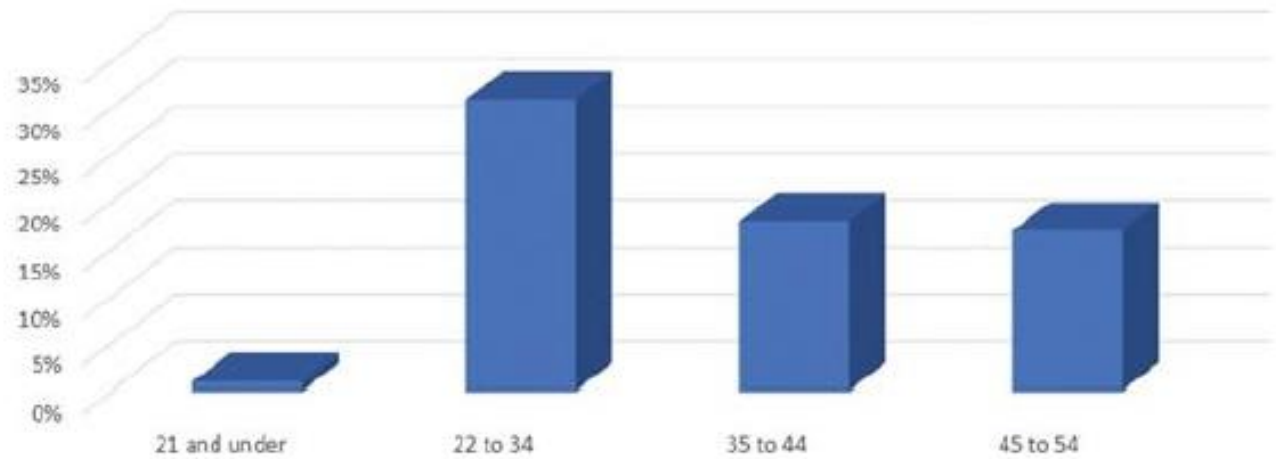
Figure 2. Years of experience reported by the survey respondents.

Thompson WR, ACSM's Health & Fitness Journal, 2017

Figure 3. Annual salary of survey respondents.

Thompson WR, ACSM's Health & Fitness Journal, 2017
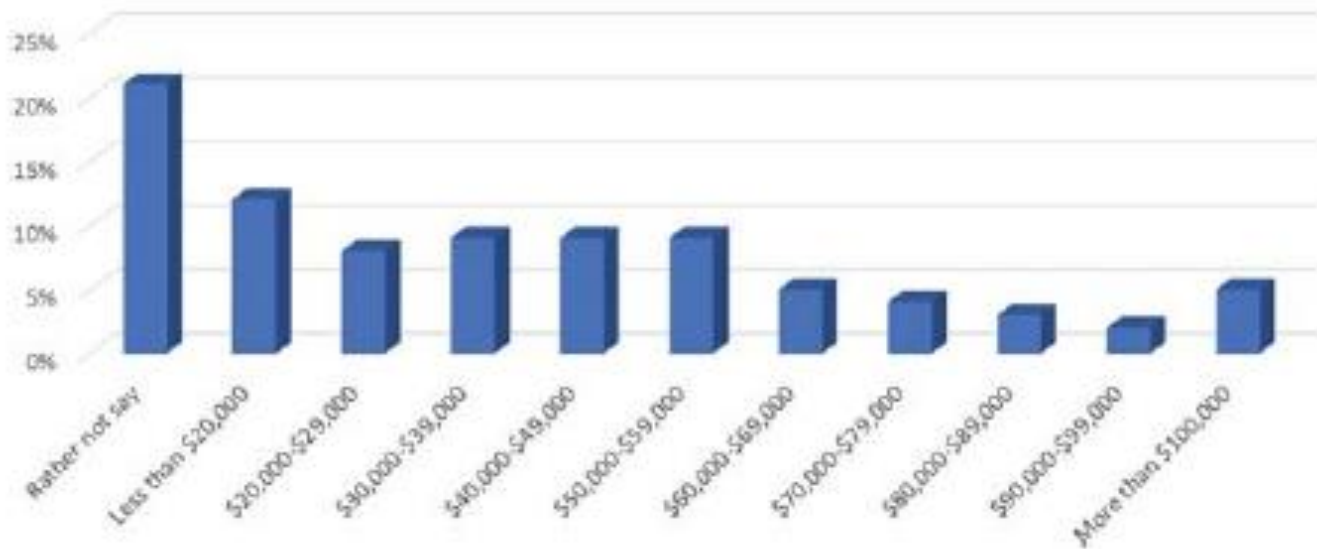
TABLE 1:
Respondents' Occupation

Respondents' Occupation	Total Respondents
Personal trainer (part-time)	17%
Personal trainer (full-time)	11%
Group exercise leader	3%
Health fitness specialist (or equivalent)	4%
Clinical exercise specialist (or equivalent)	2%
Clinical exercise physiologist	6%
Program manager	3%
Health/fitness director	5%
Owner/operator	3%
Health/wellness coach	3%
Undergraduate student	1%
Graduate student	3%
Teacher	2%
Professor	5%
Medical professional (M.D./D.O., RN, physical or occupational therapist)	4%
Registered dietician (RD, RDN, LD)	1%
Other	6%

Figure 4. Where do you work?

Thompson WR, ACSM's Health & Fitness Journal, 2017
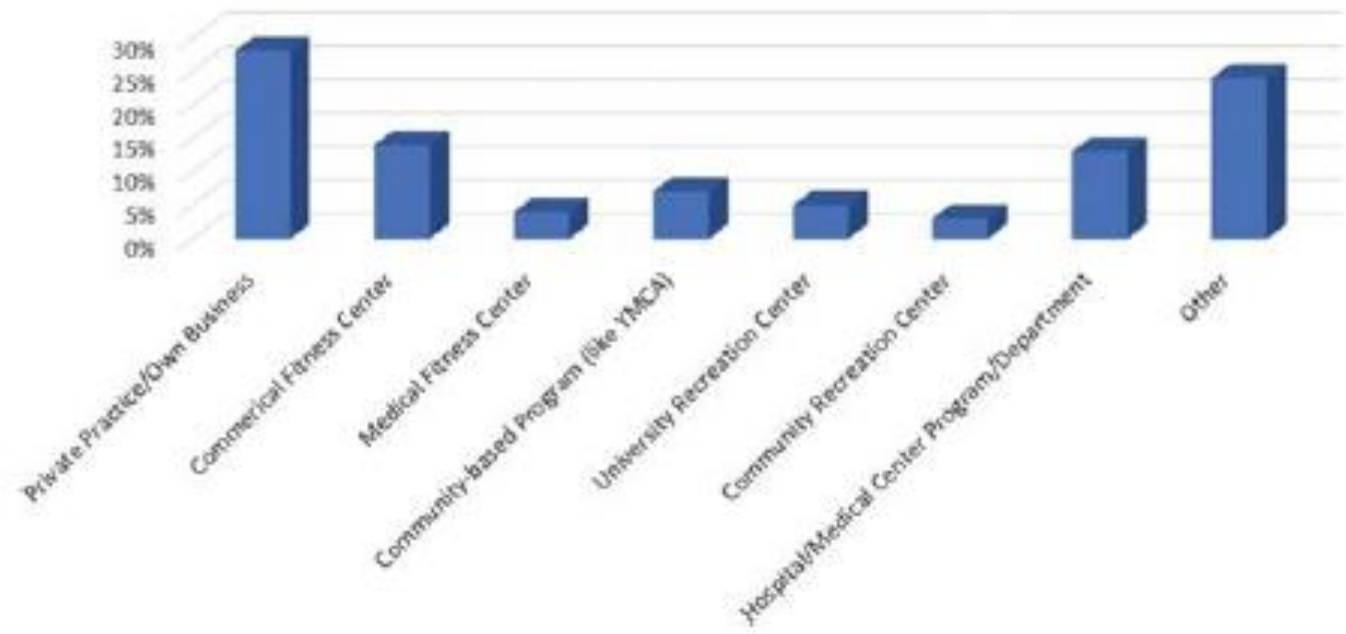
- Private practice
- Commercial Fitness Center
- Medical Fitness Center
- Community based Program
- University recreation Center
- Hospital Medical Center

TABLE 2:
### Top 20 Worldwide Fitness Trends for 2018

2018	
1	High-intensity interval training
2	Group training
3	Wearable technology
4	Body weight training
5	Strength training
6	Educated, certified, and experienced fitness professionals
7	Yoga
8	Personal training
9	Fitness programs for older adults
10	Functional fitness
11	Exercise and weight loss
12	Exercise is Medicine
13	Group personal training
14	Outdoor activities
15	Flexibility and mobility rollers
16	Licensure for fitness professionals
17	Circuit training
18	Wellness coaching
19	Core training
20	Sport-specific training

HIIT può rendere la seduta di allenamento meno noiosa… rispetto a eccessivamente lungo e lento…

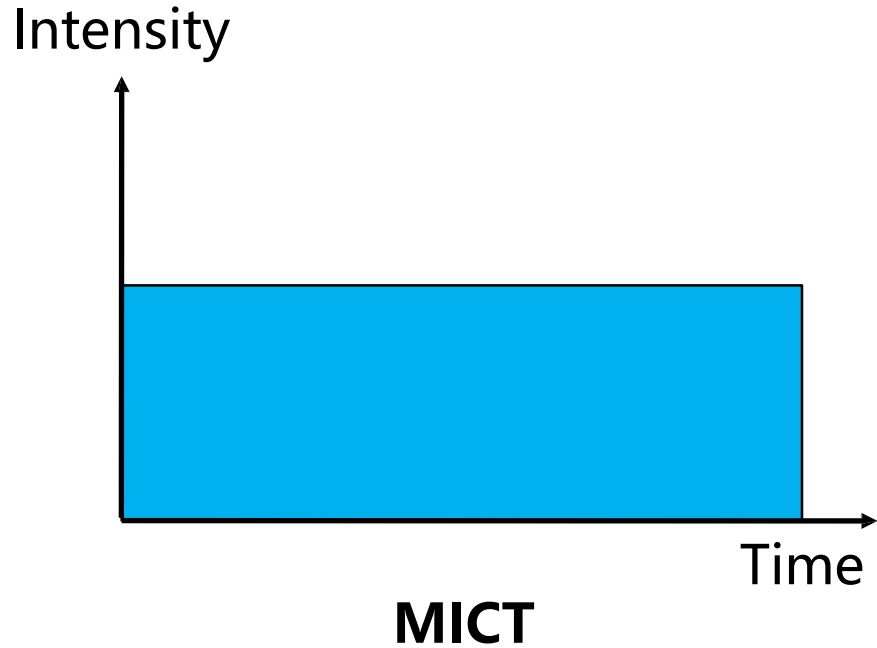# Razionale

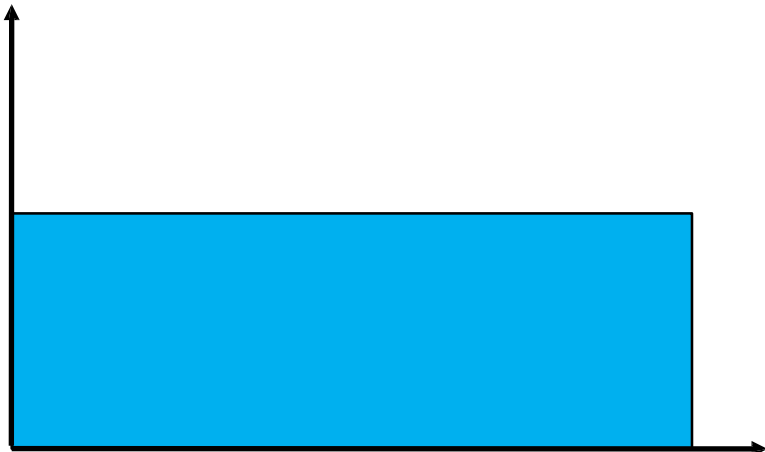# High Intensity Interval Training for Maximizing Health Outcomes
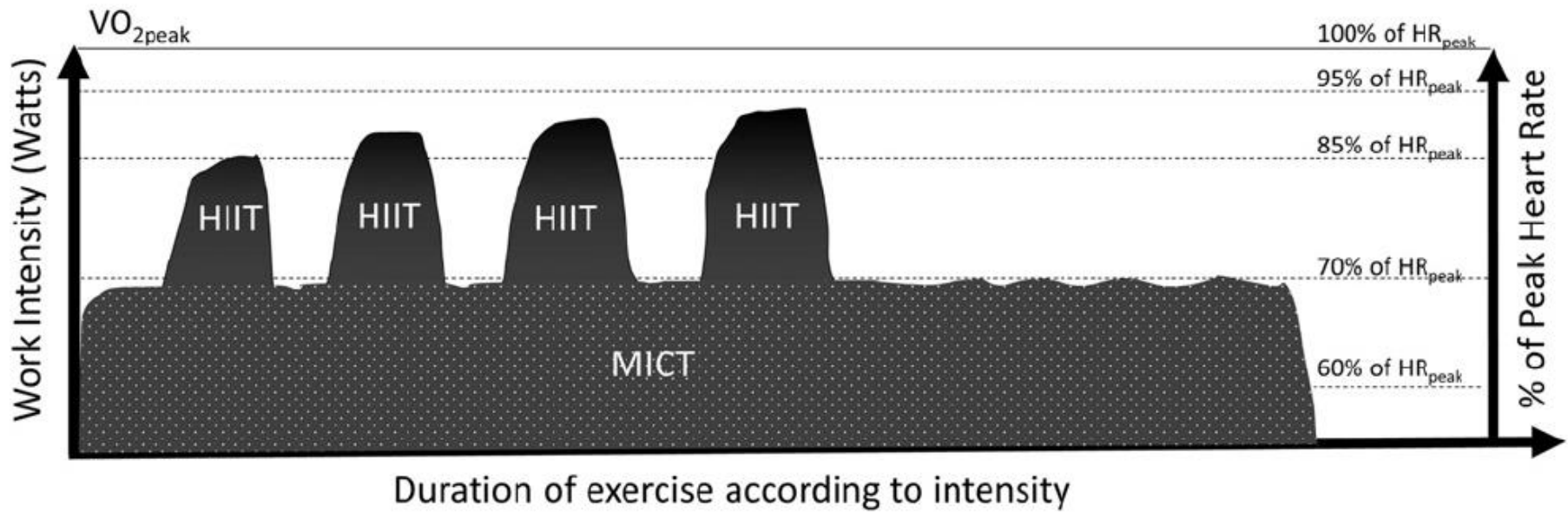
Moderate intensity continuous training (MICT)

High intensity interval training (HIIT)

High intensity interval training (HIIT)

Intensity

Time

MICT

Exercise   Recovery
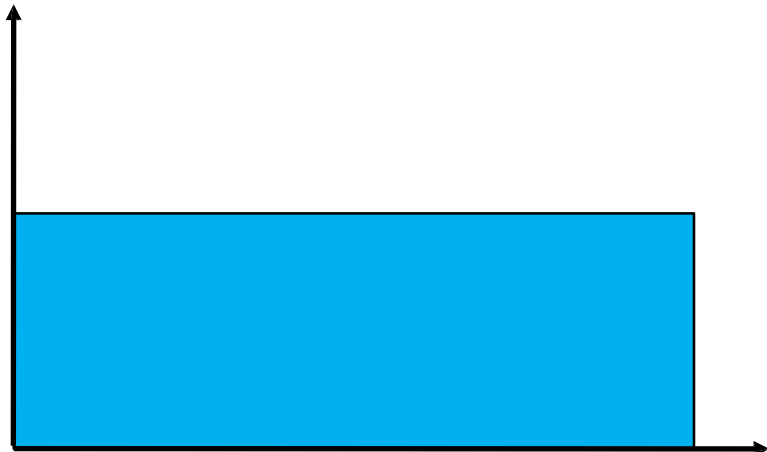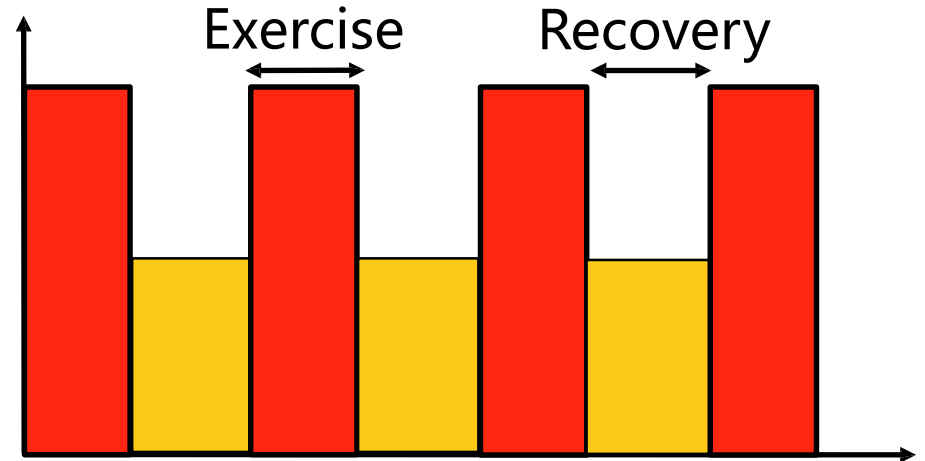
HIIT

E' qualcosa di nuovo?

La potenza aerobica nel mezzofondo e nel fondo.

Giampaolo Lenzi, marzo-aprile 1995
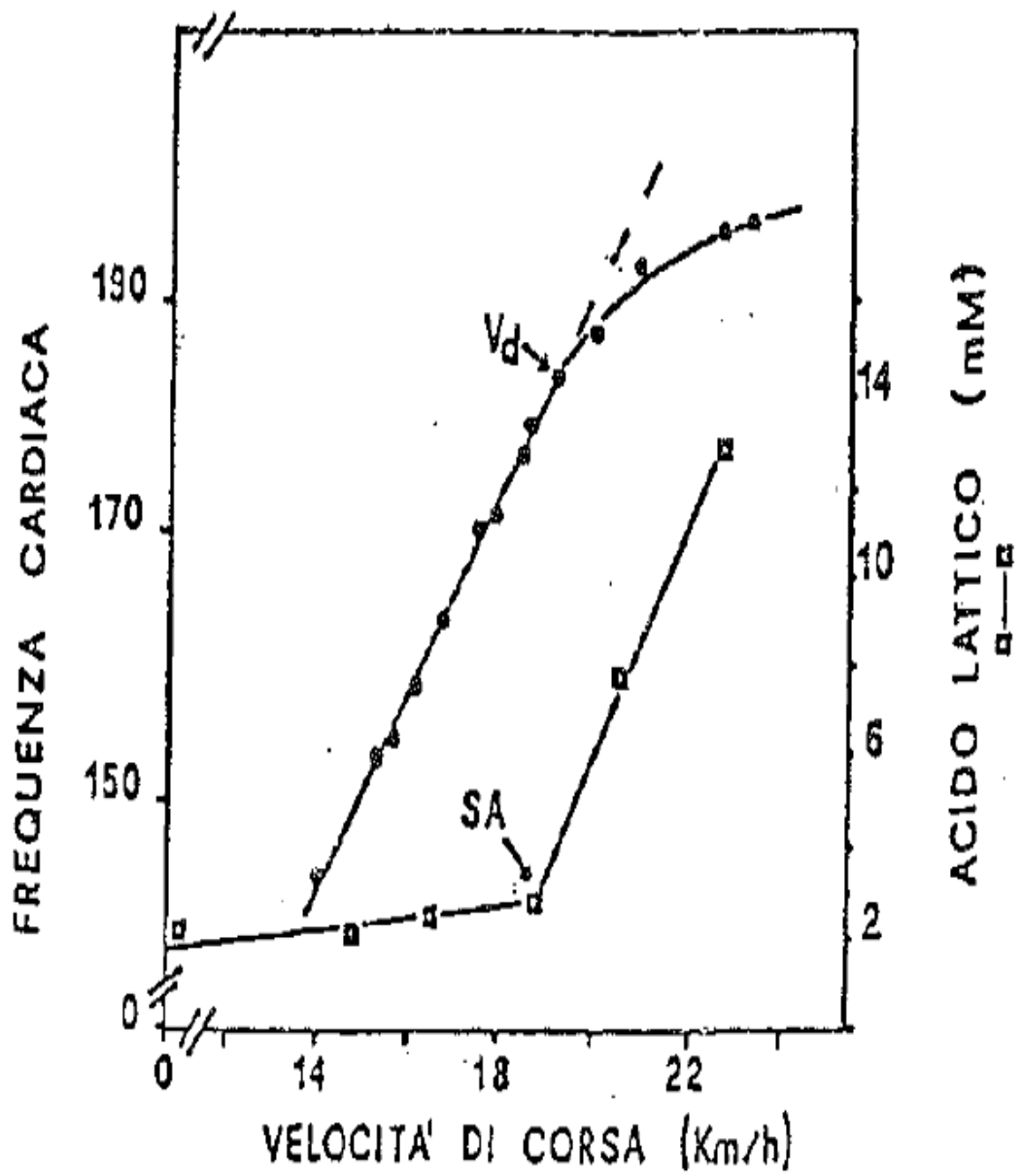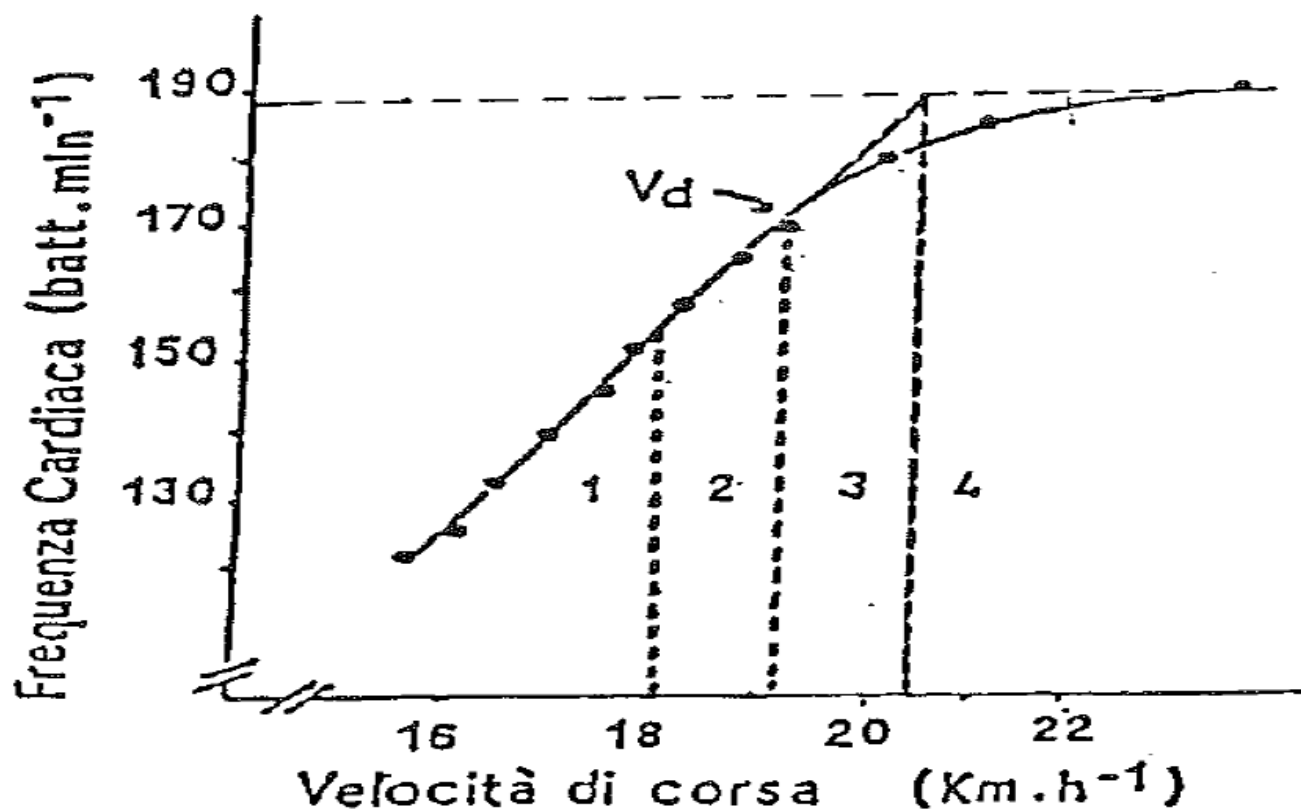
Figura 4 - Sono rappresentate le varie intensità di corsa aerobica e mista utilizzate dai corridori di mezzofondo e fondo. In ambito 1 sono comprese le velocità utilizzabili per lo sviluppo della *resistenza aerobica*, mentre correndo a velocità comprese nelle aree 2 e 3 si stimola la *potenza aerobica*. Spingendo l'intensità di lavoro in area 4 viene allenata anche la *resistenza anaerobica*, qualità necessaria soprattutto al mezzofondista veloce.

FC

FCmax

Vd

Vel

INTENSITA' PER IL MEZZOF.BREVE

INTENSITA' PER IL MEZZOF.LUNGO

INTENSITA' PER IL MARATONETA
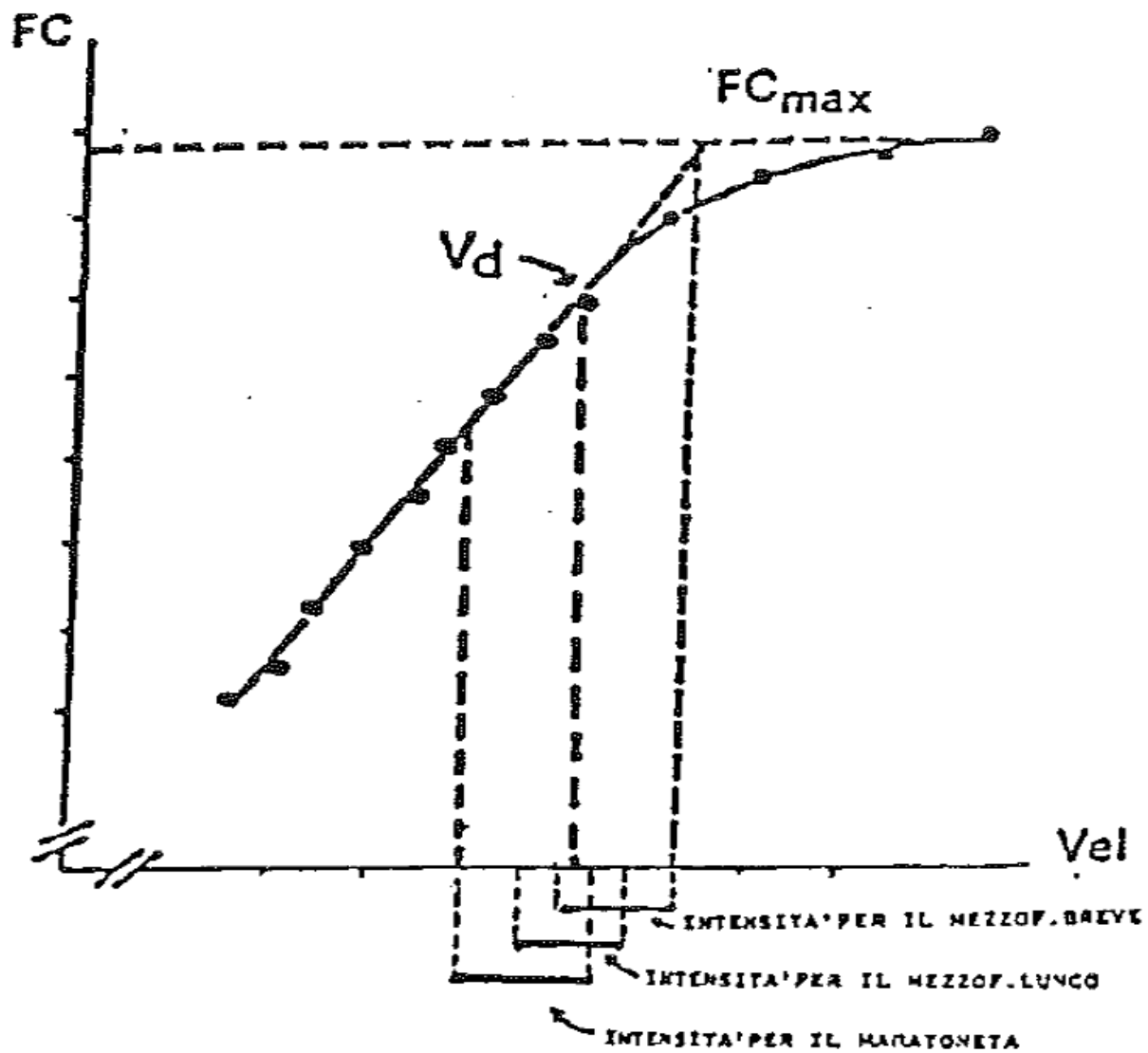
Tabella 1 - MARATONA:
ESEMPI DI ALLENAMENTO PER LO SVILUPPO "ESTENSIVO" DELLA POTENZA AEROBICA

8-10 x m. 1200	+ 1-2% di SA	rec. 2'30"-2' corsa lenta
5-6 x m. 2000	velocità di SA	rec. 2'30"-2' corsa lenta
4-5 x m. 3000	- 2-3 di SA	rec. 3'-2' corsa lenta
3-4 x m. 5000	- 3-4% di SA	rec. 3'-2'30" corsa lenta
8 x 5'		rec. 2'30"-2' corsa lenta
3 x 10' + 3 x 5'		rec. 2'30"-2' corsa lenta
5 x 10'		rec. 2'30"-2' corsa lenta
2 x 15' + 2 x 10'		rec. 2'30"-2' corsa lenta

Tabella 3 - MEZZOFONDO LUNGO: ALLENAMENTI DI "POTENZA AEROBICA"

8-10 x m. 1000 + 2-3% di SA   rec. 2'30"-1'30" corsa lenta

4-5 x m. 2000   + 1-2% di SA   rec. 2'30"-2' corsa lenta

3-4 x m. 3000   velocità di SA   rec. 3'-2' corsa lenta

10-12 x 2'-3'   rec. 2'-1'30" corsa lenta

5-6 x 5-6'   rec. 2'30"-2' corsa lenta

2 x 9' + 6' + 3'   rec. 2'30"-1'30" corsa lenta

Tabella 2 - MEZZOFONDO BREVE: ALLENAMENTI DI "POTENZA AEROBICA"

8-12 x m. 500	+ 10-12% di SA	rec. 3'-2' corsa lenta
5-8 x m. 800	+ 5-6% di SA	rec. 3'30"-3' corsa lenta
4-6 x m. 1000	+ 3-4% di SA	rec. 4'-3' corsa lenta
2-3 x m. 2000	velocità di SA	rec. 4'-3' corsa lenta
10-12 x 1'		rec. 2'-1' corsa lenta
2-3 x 3' + 2' + 1'		rec. 3'-2'-1' corsa lenta
8-10 x 2'		rec. 3'-2' corsa lenta
3 x 5' + 3 x 3'		rec. 3'30"-3' corsa lenta

Absolute workload (Watts)

Relative workload

Athlete: 100%
$HR_{peak} = 188$

95%
90%

HR = 179
HR = 169

Olympic athlete

Patient: 100%
$HR_{peak} = 130$

95%
90%

HR = 124
HR = 117

CHD-patient

4 x 4 minutes HIIT

Karlsen T. et al. Progr CVD 2017
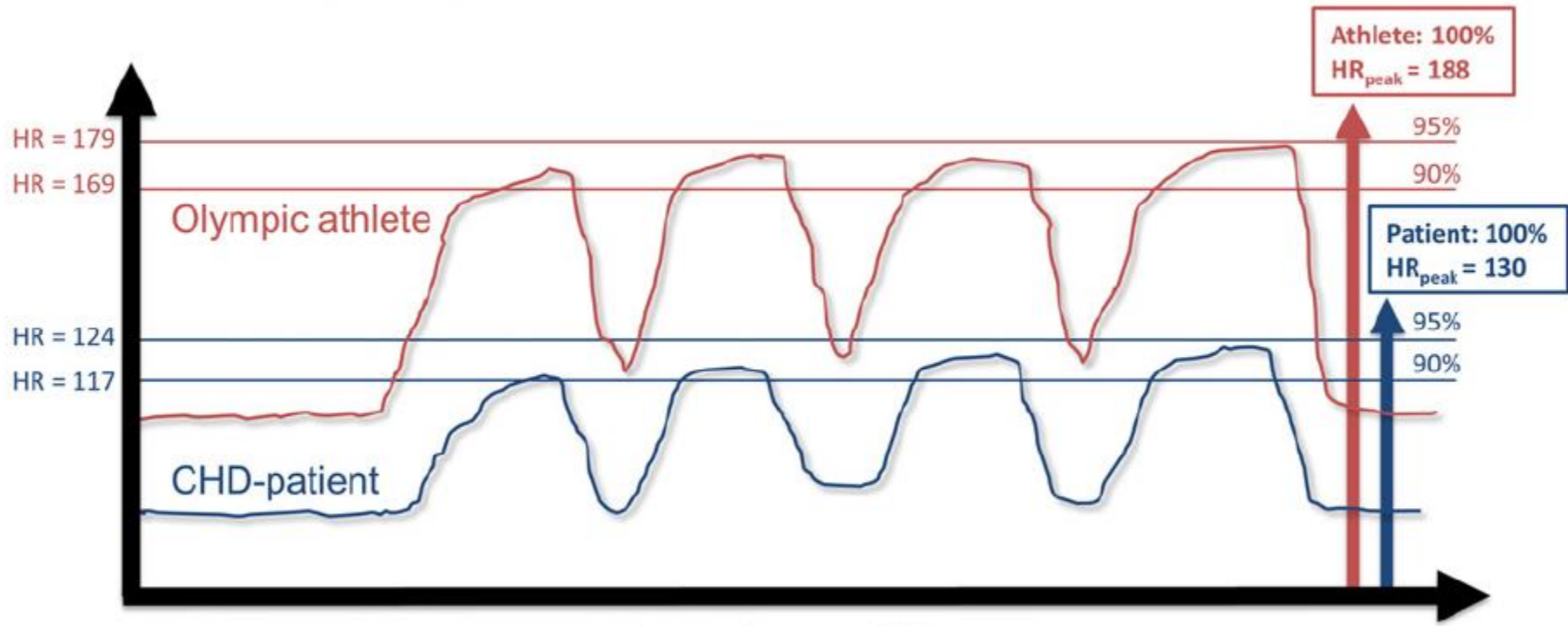
Non è una novità...

Relativamente nuovo…
in ambito «clinico»…

Principi di prescrizione di HIIT

Work interval intensity

Work interval duration

Number of repetitions

Number of series

Recovery interval intensity

Recovery interval duration

Exercise modality

Between-series recovery intensity

Between-series recovery duration
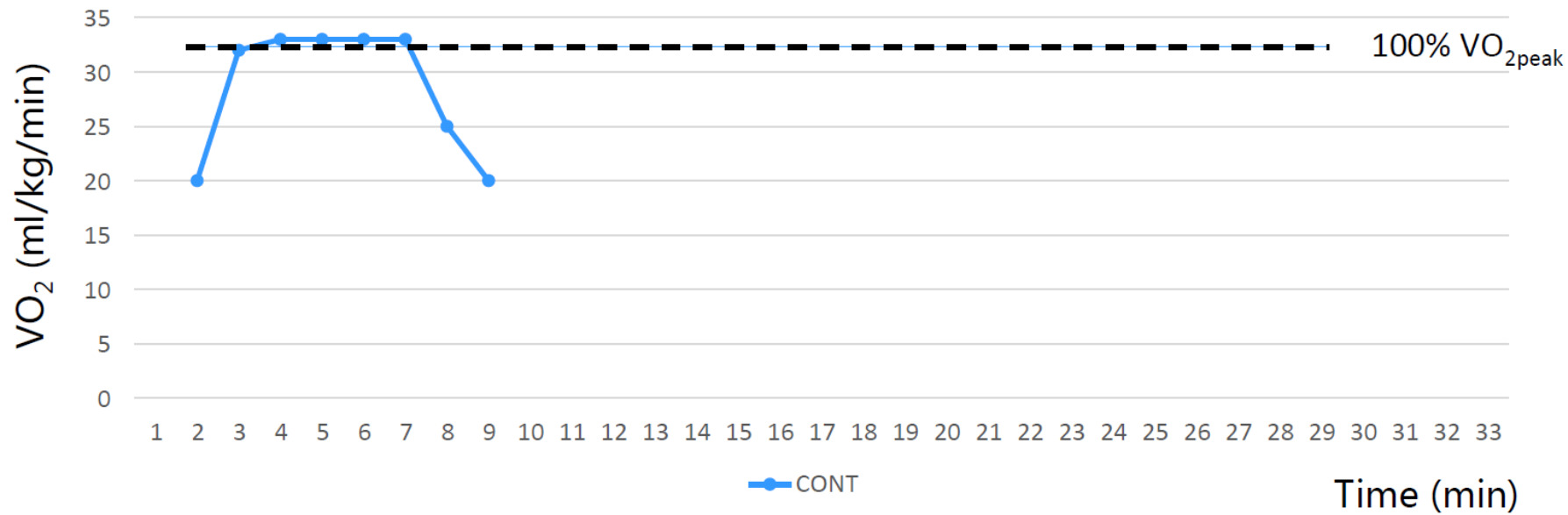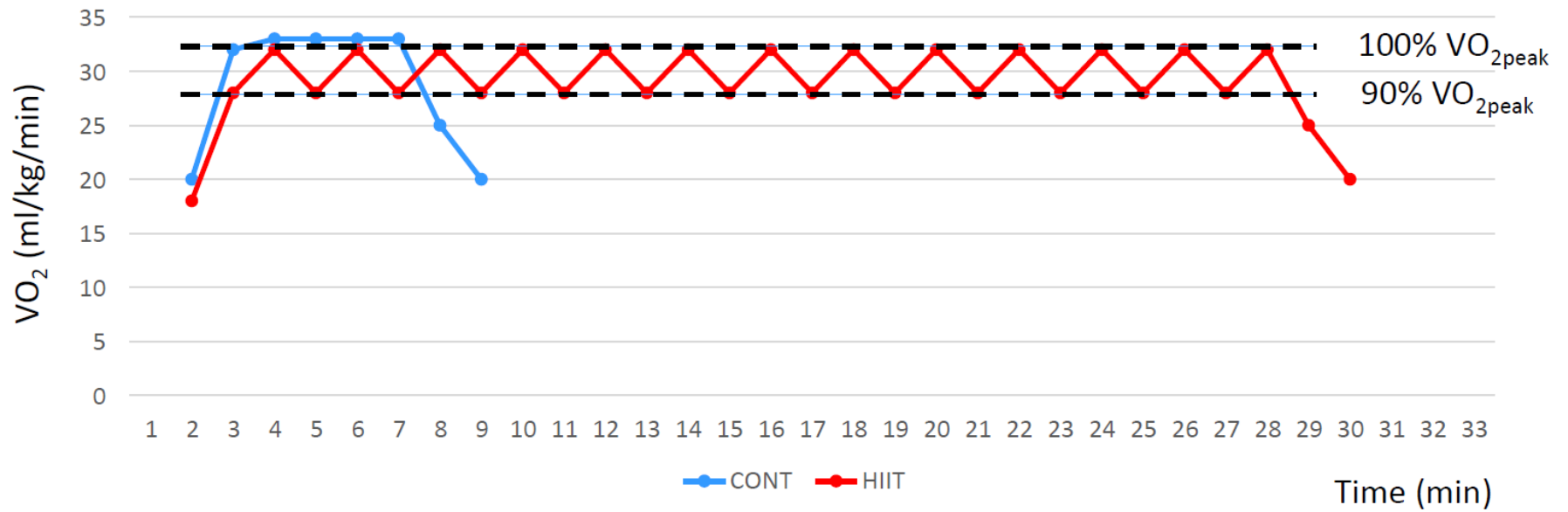
HIIT

Parametro di riferimento?

- % FC max (reale)
- % riserva FC (Karvonen)
- % carico rispetto a VO2max (watt o velocità/pendenza)
- Scale di Borg

Parametro di riferimento?

- % FC max (reale)
- % riserva FC (Karvonen)
- **% carico rispetto a VO$_2$max** (watt o velocità/pendenza)
- Scale di Borg

Uso della FC?

- Fare attenzione
- Incompetenza cronotropa (uso di β-bloccanti in % elevata di pz con CVD)
- Presenza di aritmie (FA)
- Lenta cinetica, sia nel carico che nel recupero…
- Tuttavia, «guardiamola»…

… adattamenti FC nel tempo…

- *Minore frequenza a parità di carico = miglioramento…*

- Durante step lunghi (4-5min) si può osservare una tendenza ad aumentare: quanto maggiore l'aumento, tanto meno adattati al carico proposto.

Quale protocollo

Quello più studiato:
c.d. «protocollo norvegese»
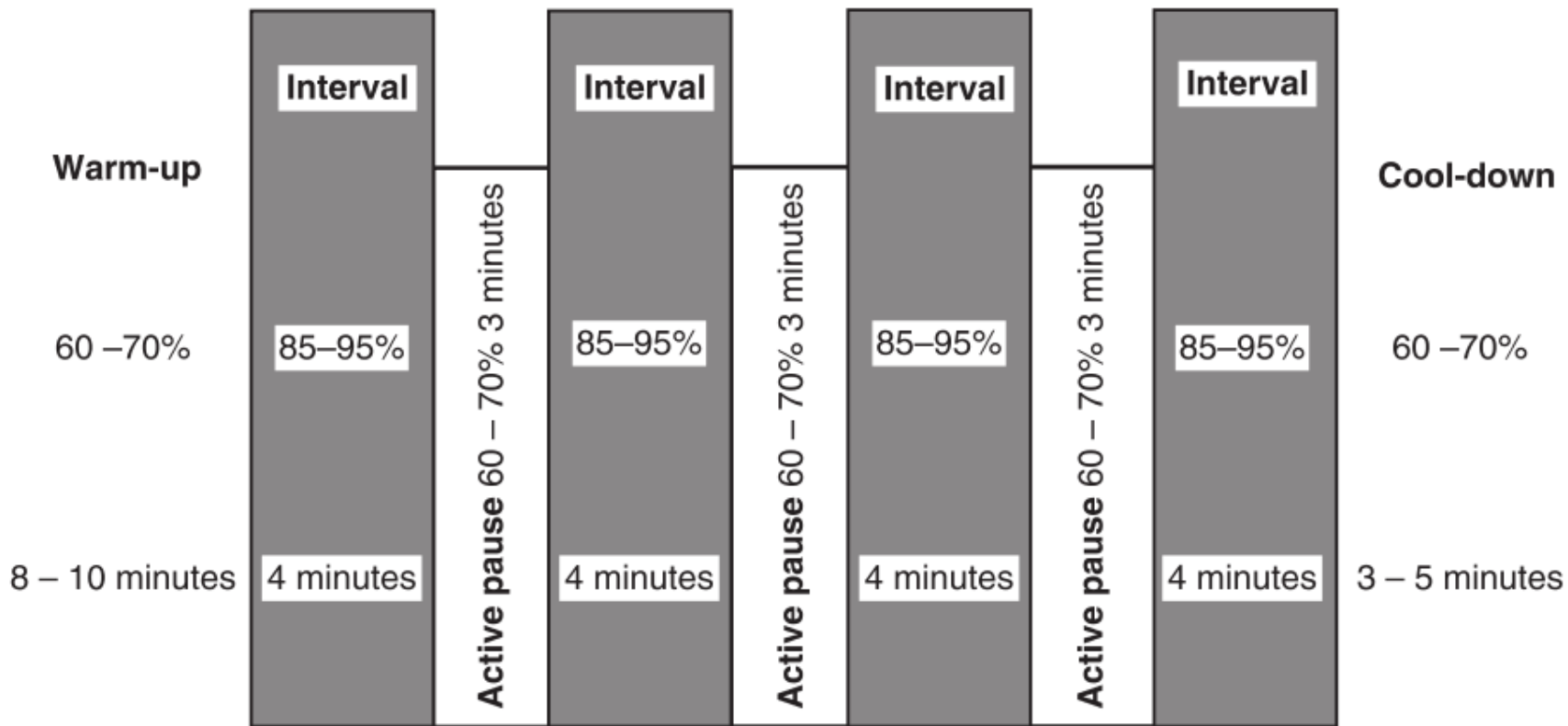
The 4 × 4 min aerobic interval training model. Intensity is given as percentage of peak heart rate.
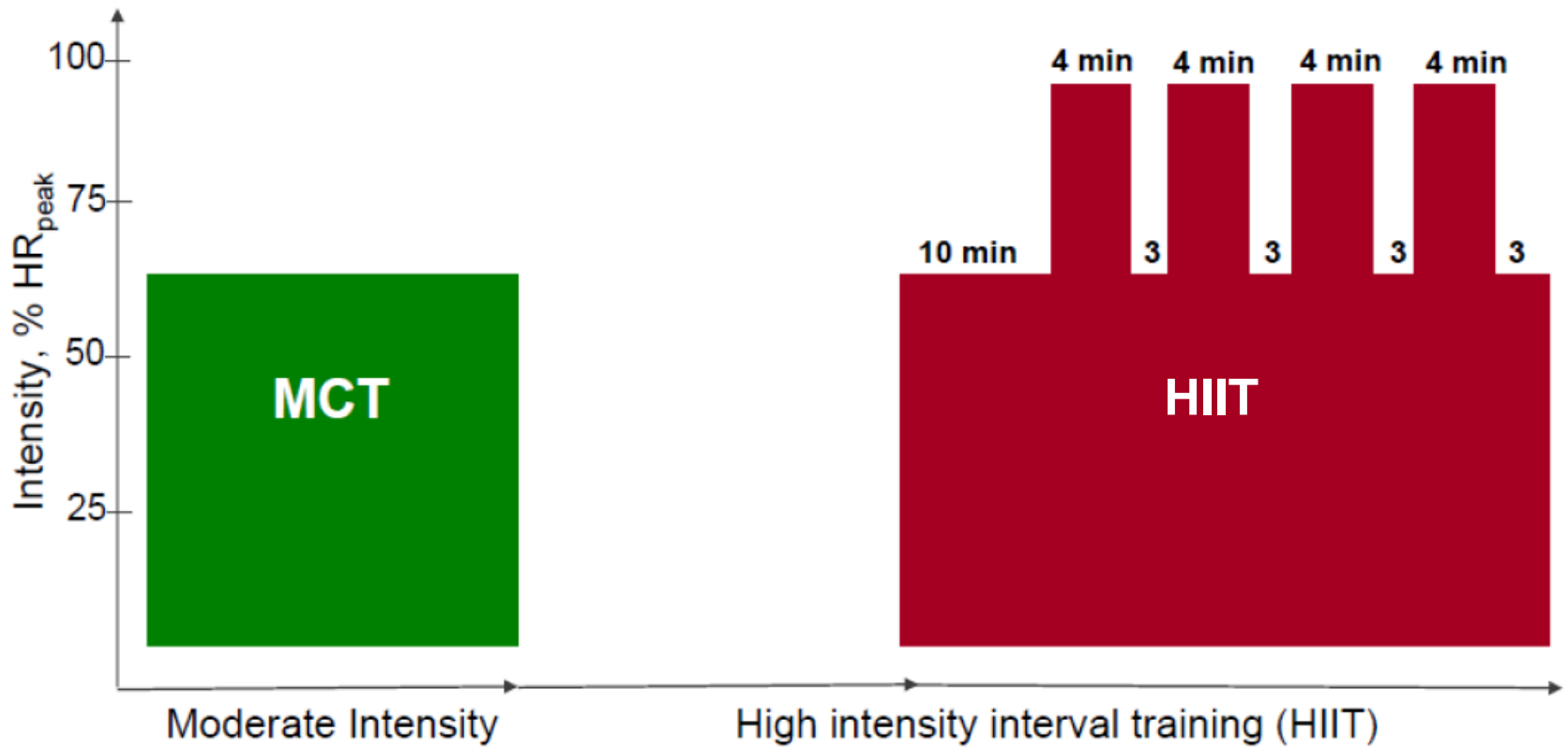
La domanda è:
HIIT è meglio di MICT?

- N =   **4,846** (M/F, 70%/30%)
- Età media: **58 a.**
- Diagnosi:
  - PTCA 40%
  - BAC 35%
  - IMA 7%
  - Sost/ripar valvolari 11%
  - CHF 7%
- Ore complessive di training: **175,820**
- Sessioni medie di training: **37** (di circa 1 ora)

Rognmo O. et al., Circulation 2012

Sicurezza

- **Ore di training HIIT**
  - HIIT: **46,364**
  - MICT: **129,456**
- **N arresti cardiaci (F/NF)**
  - HIIT: **0/2**
  - MICT: **1/0**
- **Rapporto ore training/eventi**
  - HIIT: **1/23,182**
  - MICT: **1/129,456**

Rognmo O. et al., Circulation 2012

Altri protocolli HIIT

Guiraud T. et al. Eur J Appl Physiol 2010
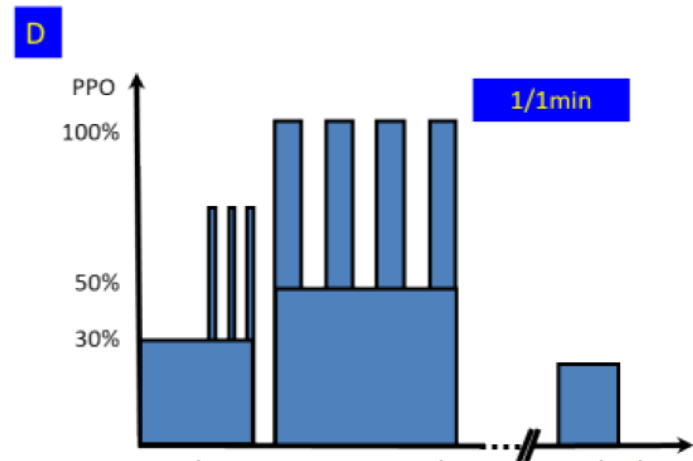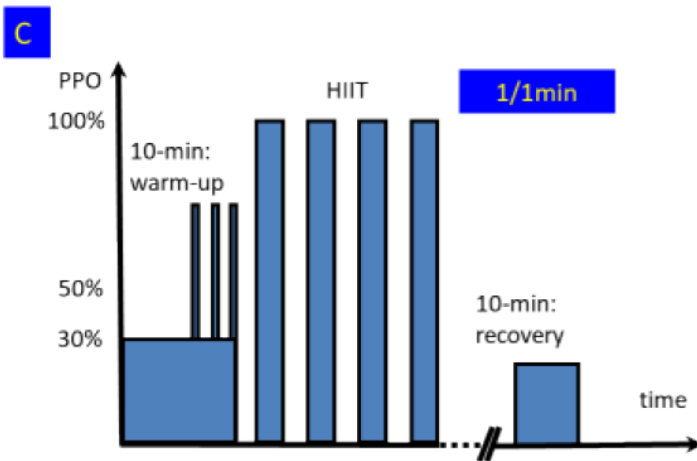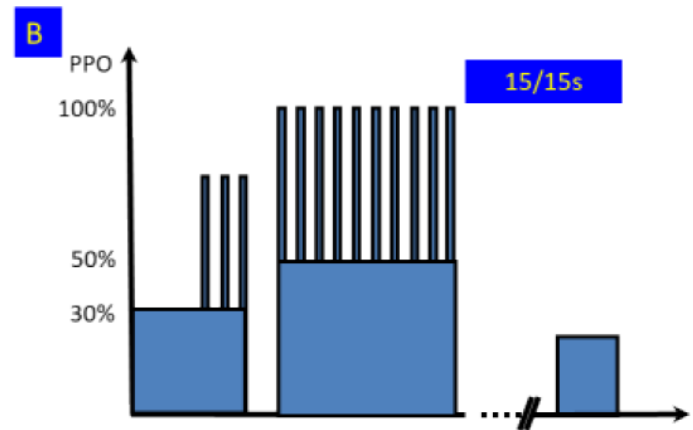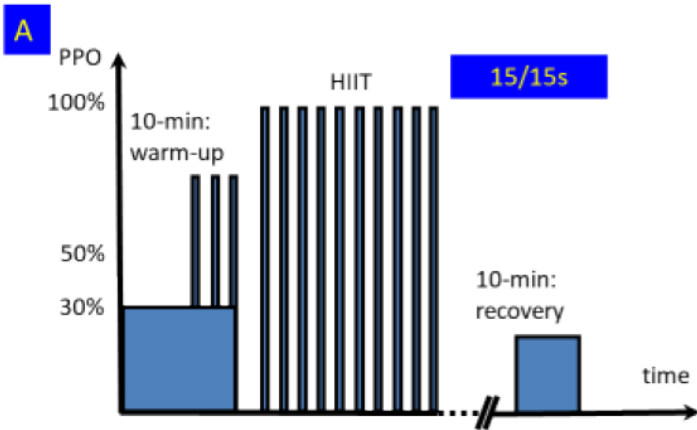
	A	B	C	D
Time to exhaustion (s)	1724 ± 482 §	733 ± 490 *	1525 ± 533 §	836 ± 505*
Time > 90% VO₂peak (s)	433 ± 486	441 ± 335	329 ± 308 §	429 ± 336
Rating perceived exertion at the end of sessions	15 ± 2 *	17 ± 2	17 ± 2	18 ± 0.6
n at 35 min	12 (63%) *	3 (16%)	8 (42%)	0

HIIT vs MICT
si intende: HIIT è meglio di MICT?

- Pressione arteriosa
- VO_2peak
- Profilo glicidico
- Profilo lipidico
- Peso/composizione corporea

HIIT vs MICT
Pressione arteriosa

n = 32 soggetti con Sindrome Metabolica

	Baseline Control	Baseline CME	Baseline AIT
Physiological			
Age, y	49.6 ± 9.0	52.0 ± 10.6	55.3 ± 13.2
Gender, M/F	5/4	4/4	4/7
Weight, kg	96.4 ± 12.1	91.2 ± 19.5	91.8 ± 17.5
Body mass index, kg/m^2	32.1 ± 3.3	29.4 ± 4.9	29.8 ± 5.5
Waist-to-hip ratio	0.97 ± 0.08	0.97 ± 0.08	0.94 ± 0.07
Medications, n			
Angiotensin II blockers	4	1	2
β-Blockers	1	1	0
Calcium antagonists	1	1	1
α-Blockers	0	0	1
Statins	0	0	2
Acetylsalicylic acid	0	0	1
Metformin	1	1	1

Data are presented as mean $\pm$ SD when appropriate.

Tjonna AE et al. Circulation 2008

MICT

- 47 min continui
- 70% FCmax (reale)
- 3/sett
- 16 settimane

HIIT

- 4 x 4min, rec 3min
- 90% FC max
- Rec 3min 70% Fcmax
- 40 min
- 3/sett
- 16 settimane

Tjonna AE et al. Circulation 2008

	Control		Moderate		Interval	
	Baseline	After	Baseline	After	Baseline	After
Blood pressure, mm Hg						
Systolic blood pressure	146±6	141±5	131±6	121±5*	144±5	135±5*
Diastolic blood pressure	95±5	96±4	88±4	82±5	95±3	89±3*
Mean arterial blood pressure	111±5	108±5	102±4	95±5*	111±3	105±3*

Conclusione su PA:
Non differenze statisticamente significative per HIIT rispetto a MICT.

Tjonna AE et al. Circulation 2008

Effects of high-intensity aerobic interval training *vs.* moderate exercise on hemodynamic, metabolic and neuro-humoral abnormalities of young normotensive women at high familial risk for hypertension

- 32 giovani donne con **famigliarità per Ipertensione**

Ciolac EG et al. Hypert Res 2010

Subjects characteristics

Variable	AIT (N=16)	CMT (N=16)	FH+ (N=12)	FH− (N=15)
History of HPT				
Father	2	5	4	—
Mother	9	3	4	—
Both	5	8	4	—
Age (years)	24.4 ± 3.8	26.6 ± 4.9	25.3 ± 3.7	25.3 ± 3.1
Weight (kg)	62.1 ± 12.5	63.5 ± 12.6	61.4 ± 11.0	62.3 ± 8.9
BMI (kg m^{-2})	23.5 ± 4.8	24.3 ± 4.6	23.8 ± 3.9	23.5 ± 2.4
Waist circumference (cm)	80.6 ± 10.8	81.4 ± 11.2	79.6 ± 12.0	79.5 ± 8.8
Waist-to-hip ratio	0.85 ± 0.04	0.86 ± 0.04	0.84 ± 0.07	0.84 ± 0.04
Office BP (mm Hg)				
Systolic	106.1 ± 9.9	105.3 ± 9.3	105.9 ± 8.3	104.0 ± 9.5
Diastolic	65.1 ± 9.5	64.9 ± 6.8	62.3 ± 8.0	62.7 ± 10.5

Abbreviations: AIT, aerobic interval training; BMI, body mass index; BP, blood pressure; CMT, continuous exercise training; FH+, control FH+ group; FH−, control FH− group; HPT, hypertension.

Protocollo

MCT

- Warm-up: 5min
- 60-70% VO2max
- Cammino
- … per 40 min

HIIT (AIT)

- Warm-up: 5min
- 1min 80-90%VO2max*
- 2min 50-60% VO2max*
- … per 40 min
- * cammino o corsa sulla base di CPET al tappeto

Variable	AIT (N=16)	CMT (N=16)	FH+ (N=12)	FH− (N=15)
24-h BP (mm Hg)				
Systolic				
Before	113.3 ± 6.4	112.6 ± 5.7	110.5 ± 4.3	110.8 ± 7.5
After	111.3 ± 5.8[c]	109.9 ± 6.7[c]	109.3 ± 5.8	111.0 ± 6.2
Diastolic				
Before	71.1 ± 3.4	69.4 ± 5.0	68.3 ± 5.2	68.9 ± 4.9
After	69.1 ± 3.8[c]	67.3 ± 3.2[c]	67.6 ± 5.6	69.1 ± 3.9

Note:
AIT = HIIT

Conclusione:
Non differenze significative fra HIIT e MCT

Ciolac EG et al. Hypert Res 2010

Aerobic interval training reduces blood pressure and improves myocardial function in hypertensive patients

n = 88

Molmen-Hansen HE et al. EJPC 2011

Protocolli

HIIT
- Warm-up: 10 min, 60% Fcmax
- 4 x 4 min, 90-95% VO2max
- Rec 3min, 60-70% Fcmax
- Tempo tot allenamento: 38 min
- 3/sett
- 12 settimane

MCT
- Warm-up: 10 min, 60% Fcmax
- 47 min
- 60% VO2max
- 3/sett
- 12 settimane

Molmen-Hansen HE et al. EJPC 2011

Measurement	AIT (n = 25)			MIT (n = 23)			Control (n = 25)		
	Baseline	Follow-up	p-values (within group/ between AIT-MIT)	Baseline	Follow-up	p-value within group	Baseline	Follow-up	p-value within group
ABP Sys (mmHg)	153.0 ± 12.3	141.0 ± 12.5	<0.001/0.02	151.0 ± 12.1	146.5 ± 13.1	0.05	153.5 ± 11.3	151.5 ± 16.0	0.32
ABP Dia (mmHg)	93.0 ± 8.2	85.0 ± 8.1	<0.001/0.06	92.0 ± 5.9	88.5 ± 8.4	0.02	92.5 ± 8.5	90.5 ± 11.5	0.20

Conclusione:
Calo significativo in entrambi i protocolli, ma più marcato in HIIT (AIT) vs MCT (MIT)

Conclusioni HIIT-PA

- Differenze fra soggetti
- Differenze fra metodi (%FC, %VO2max)
- Differenze di allenamento (cammino/corsa)
- Nell'insieme, non particolarmente evidenti vantaggi da HIIT vs MCT
- TEMPI BREVI!!! (poche settimane!!!)

HIIT e Sindrome Metabolica

Parameters Related to the Metabolic Syndrome Before and After the Experimental Period

	Control		Moderate		Interval	
	Baseline	After	Baseline	After	Baseline	After
Blood variables						
Insulin, pmol/MI	115.1±23.4	111.4±20.2	104.2±27.4	105.5±24.1	111.2±34.6	113.2±7.0
Fasting glucose, mmol/L	6.1±0.2	6.8±0.3*	6.1±0.5	6.5±0.6	6.9±0.6	6.6±0.6‡
Insulin sensitivity, (HOMA, %)	60.0±7.9	59.3±8.2	64.4±5.7	50.2±4.9	62.2±8.0	77.2±4.9*‡
β-Cell function (HOMA, %)	80.9±10.3	76.7±8.2	78.9±11.0	80.9±8.7	76.8±12.6	97.0±9.2*‡
Microalbuminuria, albumin excretion, μg/min	42.2±32.3	42.8±32.2	21.4±10.0	13.5±5.8	23.0±11.3	7.7±1.3
High-density lipoprotein, mmol/L	0.62±0.05	0.58±0.08	0.74±0.09	0.80±0.08	0.69±0.07	0.84±0.10*
Triglycerides, mmol/L	1.84±0.40	2.00±0.54	1.47±0.45	1.67±0.38	1.65±0.20	1.70±0.19
Adiponectin, μg/mL	6.4±2.0	7.0±1.1	6.7±1.5	8.2±1.4*§	7.8±2.3	9.4±3.0*§
Body composition						
Weight, kg	96.4±4.0	96.2±4.9	91.2±6.9	87.6±6.5*	91.8±5.3	89.5±4.9*
Body mass index, kg/m^2	32.1 1.1	32.0±1.3	29.4±1.7	28.2±1.5*§	29.8±1.7	29.1±1.5*
Waist, cm	114.3±2.7	112.0±3.4	105.1±5.3	99.1±5.0*§	105.5±4.1	100.5±3.6*
Waist-to-hip ratio	0.97±0.03	0.96±0.03	0.97±0.03	0.93±0.03	0.94±0.02	0.94±0.02
Blood pressure, mm Hg						
Systolic blood pressure	146±6	141±5	131±6	121±5*	144±5	135±5*
Diastolic blood pressure	95±5	96±4	88±4	82±5	95±3	89±3*
Mean arterial blood pressure	111±5	108±5	102±4	95±5*	111±3	105±3*

Conclusioni:
HIIT > MCT x peso corporeo + grasso viscerale
HIIT = MCT x altri fattori

HIIT e Diabete Mellito di tipo II

Feasibility and preliminary efficacy of high intensity interval training in type 2 diabetes[☆]

Protocollo

HIIT

- Cammino e ciclo
- 5/sett
- 12 settimane
- Durata a crescere:
- 1-4: 30min
- 5-8: 45min
- 9-12: 60min
- 7 x 1min 100% VO_2R
- Rec 3 min 40% VO_2R
- Resto a 40% VO_2R

MICT

- Cammino e ciclo
- 5/sett
- 12 settimane
- Durata a crescere:
- 1-4: 30min
- 5-8: 45min
- 9-12: 60min
- 40% VO_2R

Terada T. et al. Diab Res Clin Pract 2013

Table 1 – Baseline blood profiles, anthropometric measures, body fat, and exercise performance changes over 12-week exercise training.

Variable	Intervention	Baseline	12 weeks	Changes from baseline	p-Value[a]
n (M/F)	HI-IE	4/4	4/4		
	MI-CE	4/3	4/3		
Age (y)	HI-IE	62 (3)			
	MI-CE	63 (5)			
T2DM duration (y)	HI-IE	6 (4)			
	MI-CE	8 (4)			
Body weight (kg)	HI-IE	80.5 (9.9)	79.7 (10.2)	−0.8 (2.4)	NS
	MI-CE	93.9 (18.3)	92.6 (18.8)	−1.3 (0.9)	NS
BMI (kg/m²)	HI-IE	28.4 (4.1)	28.1 (4.0)	−0.3 (0.9)	NS
	MI-CE	33.1 (4.5)	32.6 (4.3)	−0.5 (0.9)	NS
Total body fat (%)	HI-IE	36.1 (10.9)	34.2 (10.4)	−1.9 (1.4)	0.009
	MI-CE	41.6 (6.3)	40.1 (5.6)	−1.5 (1.5)	0.028
Trunk fat (%)	HI-IE	41.7 (8.9)	39.2 (8.8)	−2.5 (1.6)	0.007
	MI-CE	46.1 (6.3)	44.3 (5.5)	−1.8 (2.4)	0.075
Arm fat (%)	HI-IE	33.3 (15.8)	33.2 (15.5)	−0.1 (1.3)	NS
	MI-CE	40.0 (8.1)	39.6 (7.1)	−0.4 (2.1)	NS
Leg fat (%)	HI-IE	30.0 (13.8)	28.4 (12.9)	−1.6 (1.6)	0.032
	MI-CE	36.7 (7.5)	35.4 (7.1)	−1.3 (1.5)	0.049
Sagittal diameter (cm)	HI-IE	24.2 (1.8)*	24.3 (2.1)	0.2 (0.9)	NS
	MI-CE	27.7 (3.7)	28.2 (3.3)	0.5 (1.3)	NS
Waist circumference (cm)	HI-IE	102.6 (7.2)*	102.2 (6.9)	−0.5 (2.6)	NS
	MI-CE	116.3 (11.0)	115.1 (11.5)	−1.2 (3.5)	NS
Hip circumference (cm)	HI-IE	107.1 (10.3)	105.4 (9.4)	−1.7 (2.4)	NS
	MI-CE	116.0 (6.7)	114.3 (8.9)	1.7 (4.9)	NS
Subcutaneous fat width (cm)	HI-IE	4.4 (1.6)	4.1 (1.6)	−0.3 (0.2)	0.029
	MI-CE	5.8 (1.9)	5.3 (1.9)	−0.5 (0.6)	0.042

Terada T. et al. Diab Res Clin Pract 2013

Table 1 – Baseline blood profiles, anthropometric measures, body fat, and exercise performance changes over 12-week exercise training.

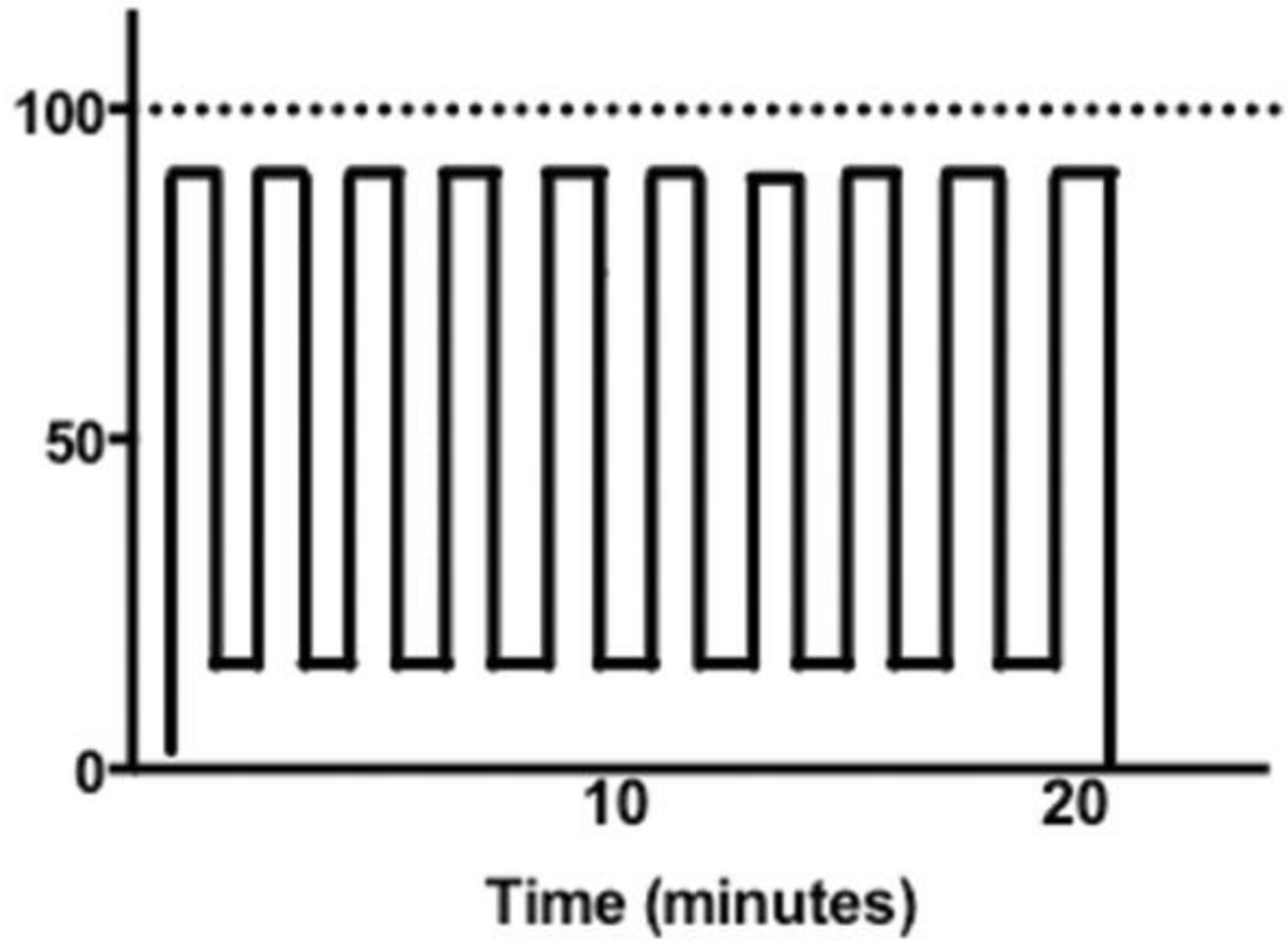| Variable	Intervention	Baseline	12 weeks	Changes from baseline	p-Value[a]
Fasting glucose (mmol/l)	HI-IE	6.8 (0.8)	6.7 (0.8)	−0.1 (0.8)	NS
	MI-CE	7.3 (1.7)	7.6 (3.0)	0.3 (2.9)	NS
	MI-CE[b]	7.3 (1.8)	6.7 (1.3)	−0.6 (0.9)	NS
HbA1c (%)	HI-IE	6.6 (0.6)	6.5 (0.5)	−0.1 (0.3)	NS
	MI-CE	6.7 (0.9)	7.0 (1.1)	0.3 (0.5)	NS
	MI-CE[b]	6.6 (0.9)	6.7 (0.8)	0.1 (0.3)	NS
HDL (mmol/l)	HI-IE	1.2 (0.2)	1.2 (0.2)	0.0 (0.1)	NS
	MI-CE	1.3 (0.4)	1.3 (0.4)	0.0 (0.1)	NS
LDL (mmol/l)	HI-IE	2.0 (0.2)	2.2 (0.6)	0.2 (0.6)	NS
	MI-CE	1.8 (0.7)	1.8 (0.7)	0.0 (0.4)	NS
Cholesterol (mmol/l)	HI-IE	3.9 (0.4)	4.0 (1.0)	0.2 (0.9)	NS
	MI-CE	3.9 (0.5)	3.8 (0.8)	−0.1 (0.3)	NS
Cholesterol to HDL ratio	HI-IE	3.2 (0.3)	3.5 (0.7)	0.2 (0.7)	NS
	MI-CE	3.3 (1.1)	3.2 (1.3)	−0.1 (0.4)	NS
Triglyceride (mmol/l)	HI-IE	1.5 (0.4)	1.6 (0.9)	0.1 (0.7)	NS
	MI-CE	2.1 (0.8)	1.6 (0.9)	−0.5 (1.2)	NS

In estrema sintesi:

- HIIT > MICT (modesto effetto) x profilo glicidico
- HIIT = MICT x altri comuni fattori di rischio

Effectiveness and Safety of High-Intensity Interval Training in Patients With Type 2 Diabetes

10x1min, 90% VO2max, Rec 1min fermo.

Francois ME et al. Diab Spectrum 2015

Francois ME et al. Diab Spectrum 2015

Francois ME et al. Diab Spectrum 2015
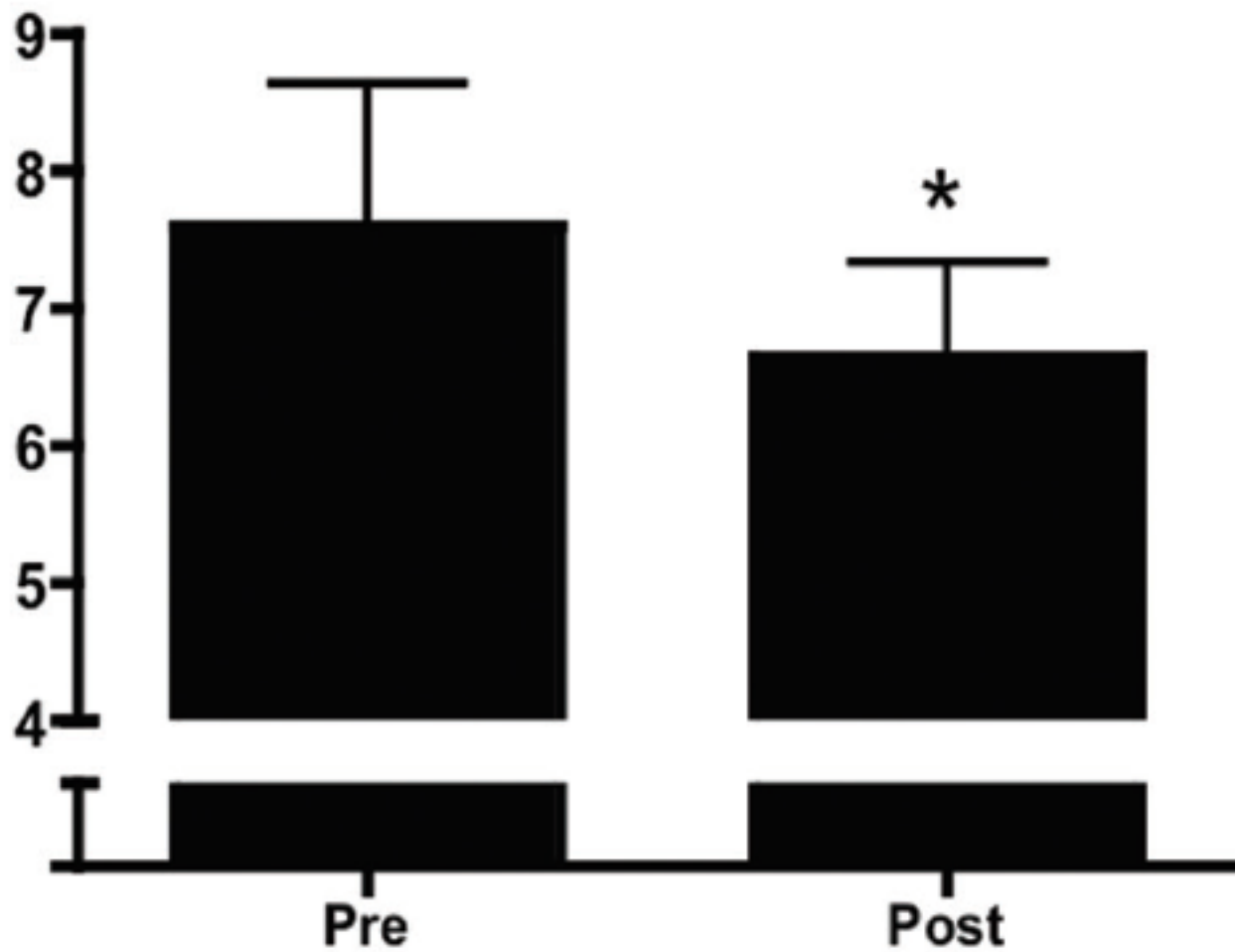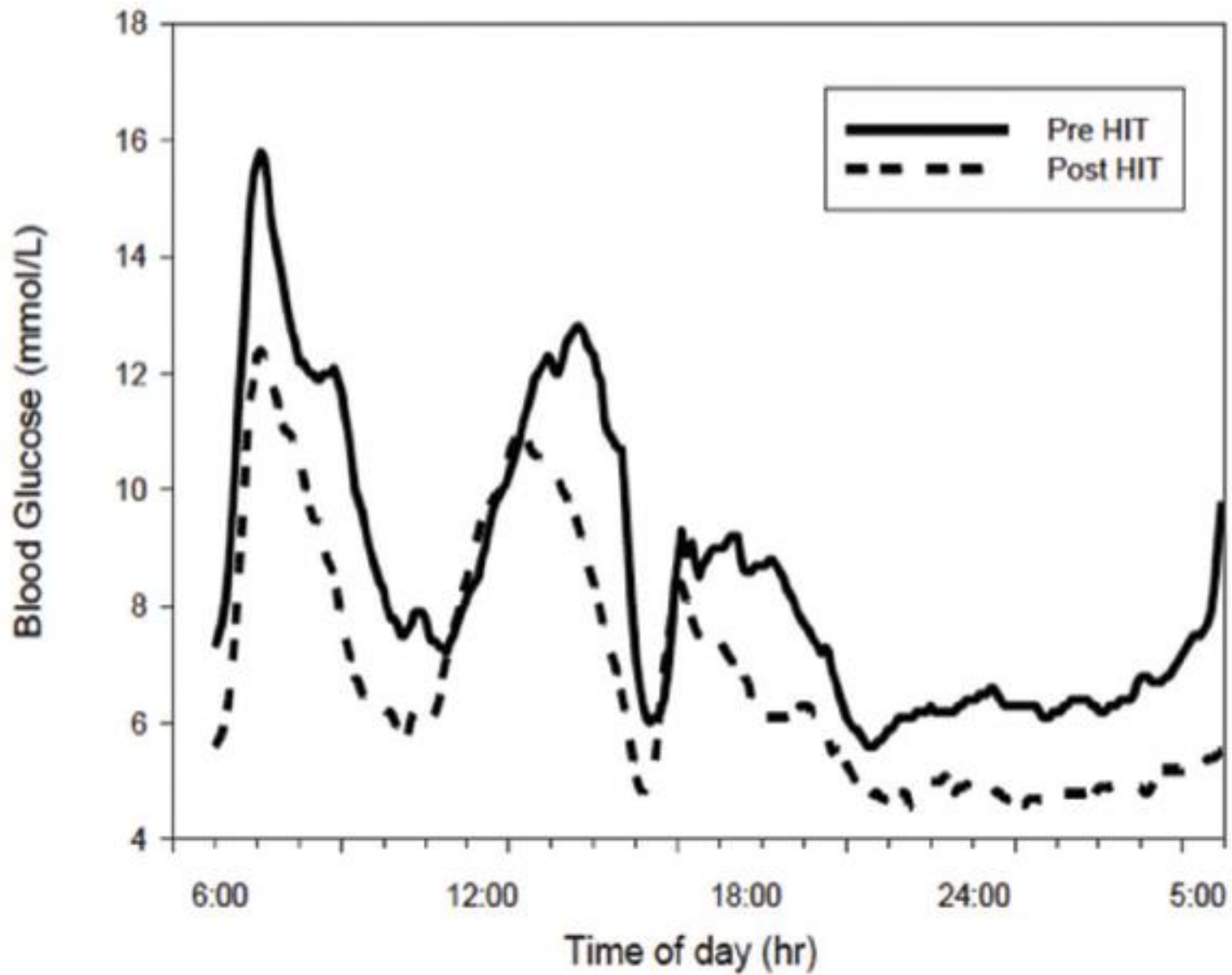
Effects of high-intensity interval training on cardiometabolic health: a systematic review and meta-analysis of intervention studies

Normopeso

Batacan RB et al. BJSM 2018
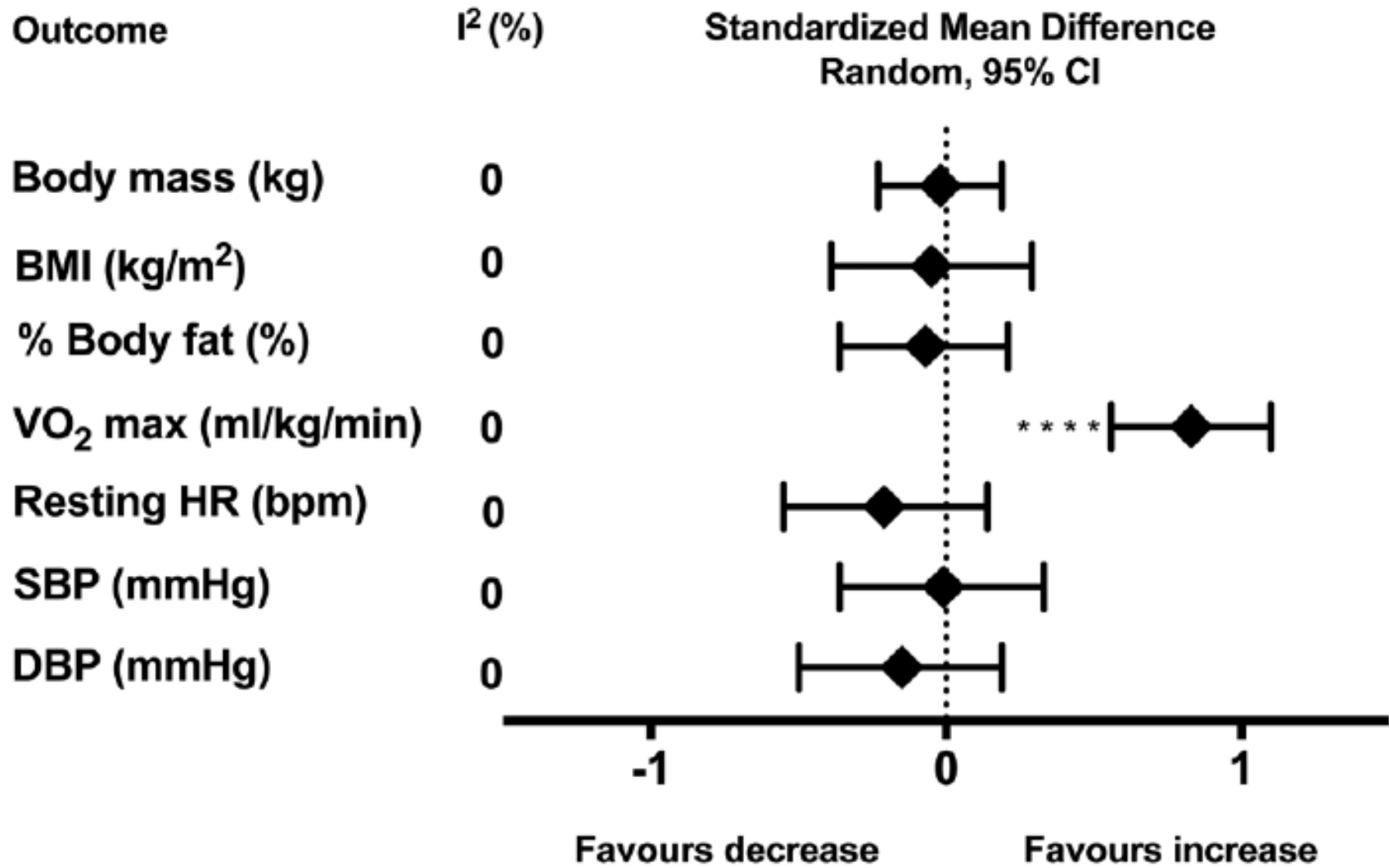
What are the findings?

▶ At least 12 weeks of high-intensity interval training (HIIT) improves cardiometabolic risk factors such as waist circumference, % body fat, resting heart rate, systolic blood pressure and diastolic blood pressure in overweight/obese populations.

▶ Improvements in aerobic capacity are larger with longer training periods.

▶ The effect of HIIT on inflammation is not clear due to the limited number of studies available.

Batacan RB et al. BJSM 2018

How might it impact on clinical practice in the future?

▶ High-intensity interval training (HIIT) performed at least 3 times a week for 12 weeks results in significant, positive, physiological adaptations that improve cardiometabolic health in overweight/obese populations.

▶ HIIT may reduce the development and progression of disease-related risk factors that are associated with overweight/obesity and low aerobic fitness.

▶ HIIT may be especially attractive to overweight/obese populations interested in improving cardiometabolic health but with limited time available.

Outcome	I^2 (%)	Standardized Mean Difference Random, 95% CI
Body mass (kg)	0	
% Body fat (%)	0	
VO$_2$ max (mL/kg/min)	0	* * *
SBP (mmHg)	0	
DBP (mmHg)	0	* *
FG (mmol/L)	0	* *
FI (µIU/mL)	0	

Favours decrease   Favours increase
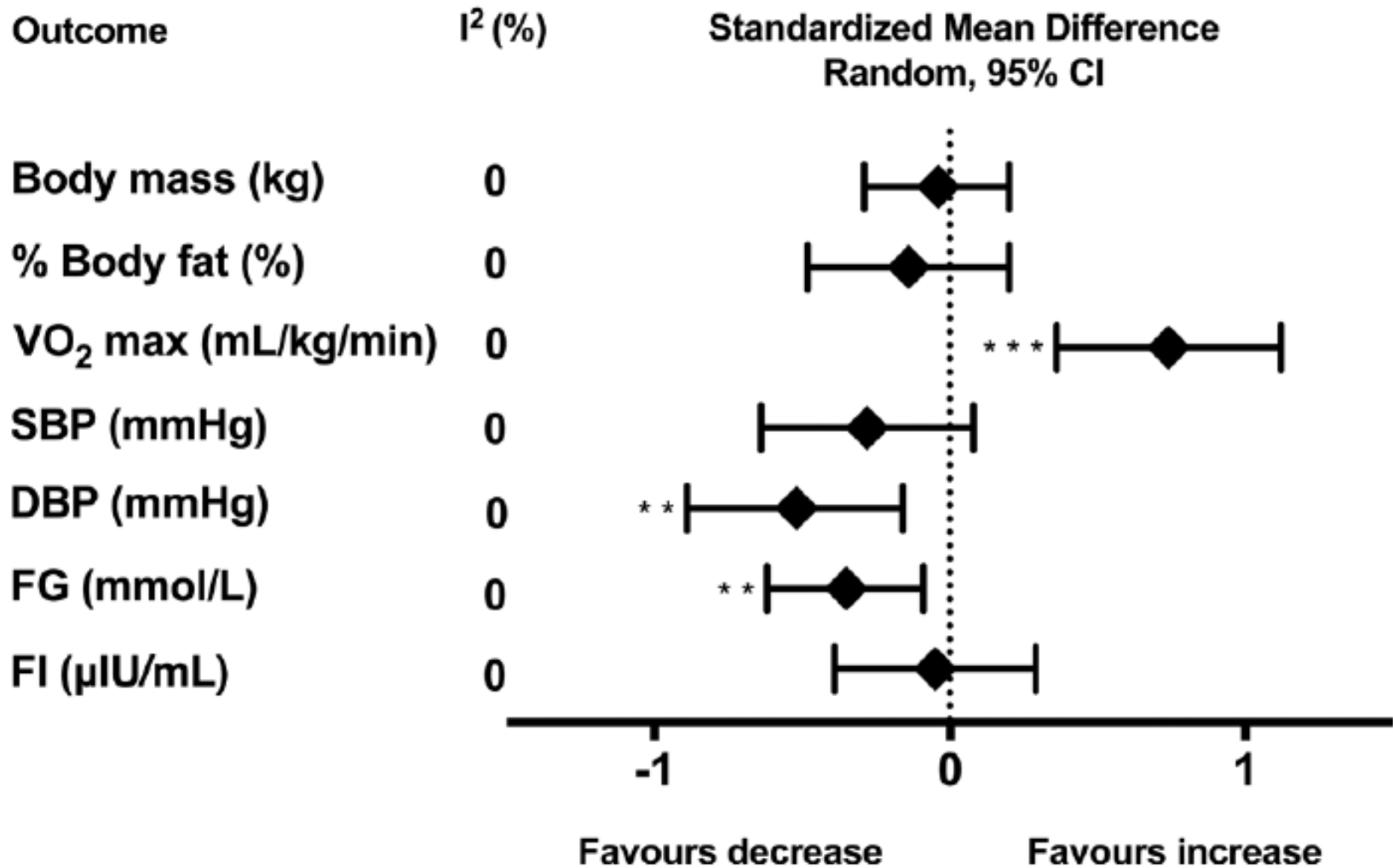
Sovrappeso/Obesi
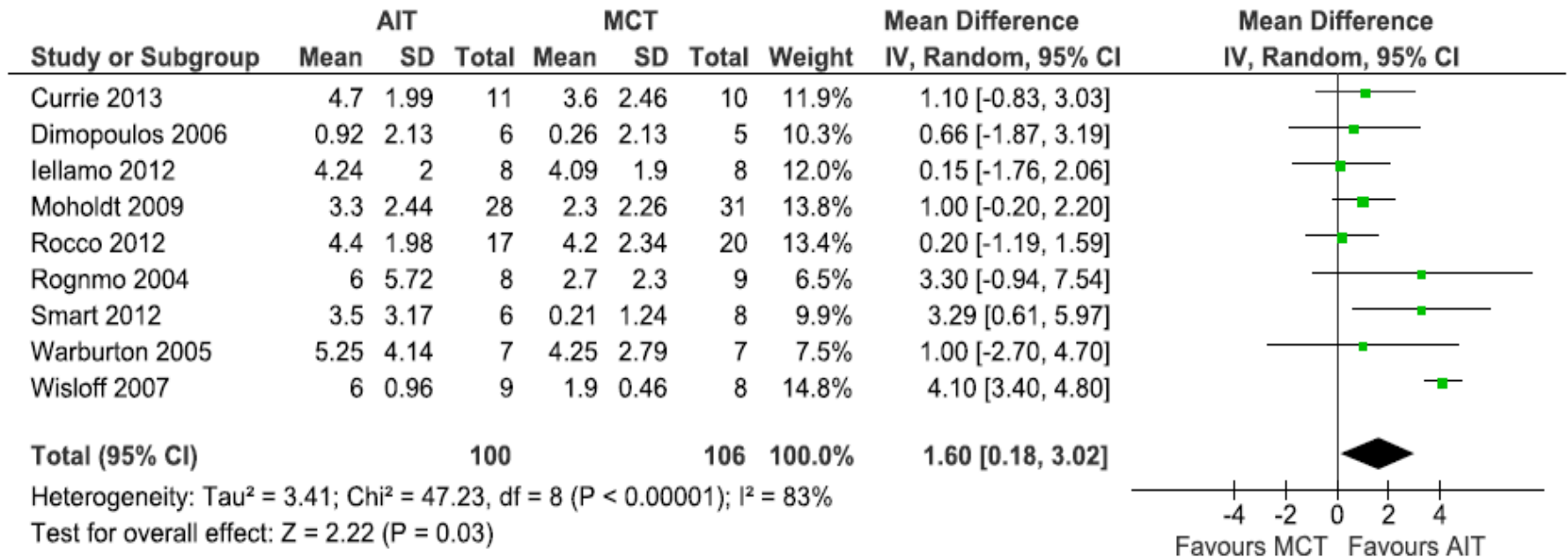FG: Fasting Glucose
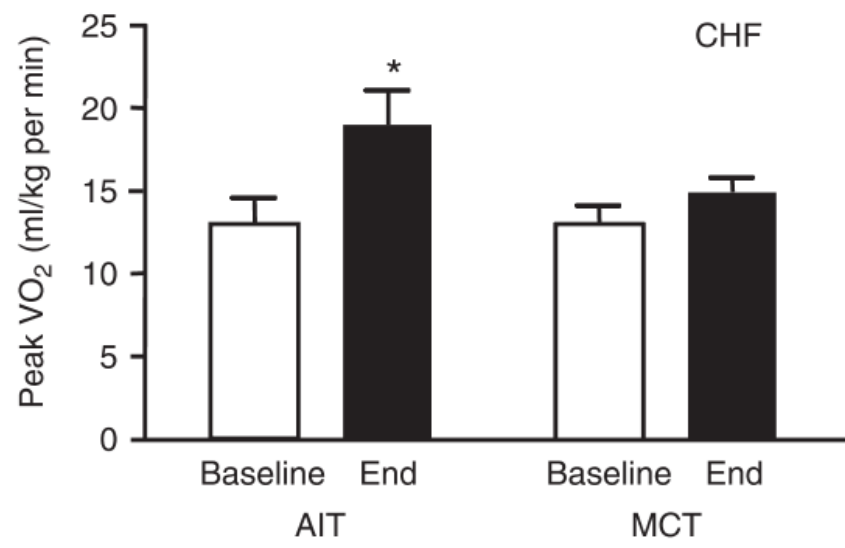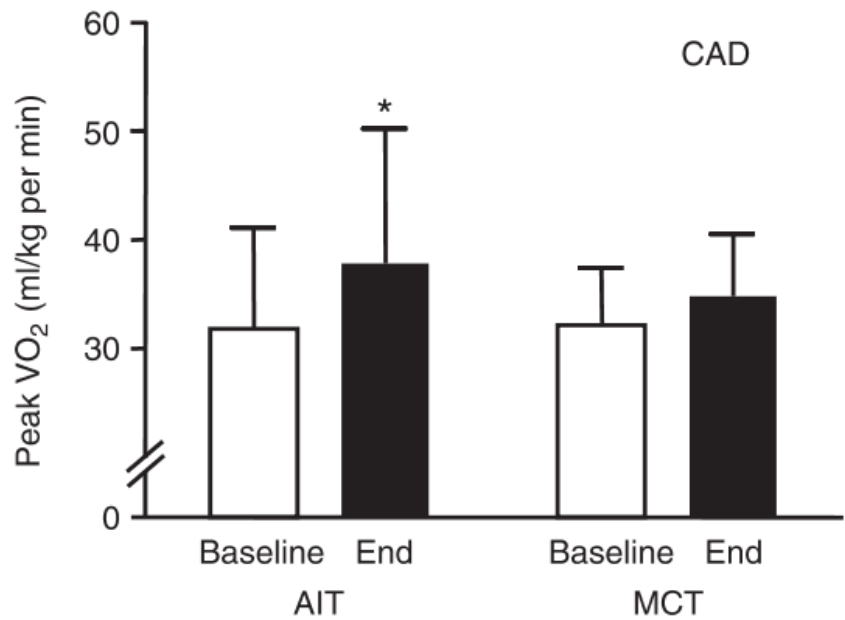FI: Fasting Insulin

Batacan RB et al. BJSM 2018

HIIT e Cardiopatia ischemica

Aerobic Interval Training vs. Moderate Continuous Training in Coronary Artery Disease Patients: A Systematic Review and Meta-Analysis

VO$_2$peak

Interval Training vs. Continuous Training in CAD Patients

Study or Subgroup	AIT Mean	SD	Total	MCT Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Currie 2013	4.7	1.99	11	3.6	2.46	10	11.9%	1.10 [-0.83, 3.03]
Dimopoulos 2006	0.92	2.13	6	0.26	2.13	5	10.3%	0.66 [-1.87, 3.19]
Iellamo 2012	4.24	2	8	4.09	1.9	8	12.0%	0.15 [-1.76, 2.06]
Moholdt 2009	3.3	2.44	28	2.3	2.26	31	13.8%	1.00 [-0.20, 2.20]
Rocco 2012	4.4	1.98	17	4.2	2.34	20	13.4%	0.20 [-1.19, 1.59]
Rognmo 2004	6	5.72	8	2.7	2.3	9	6.5%	3.30 [-0.94, 7.54]
Smart 2012	3.5	3.17	6	0.21	1.24	8	9.9%	3.29 [0.61, 5.97]
Warburton 2005	5.25	4.14	7	4.25	2.79	7	7.5%	1.00 [-2.70, 4.70]
Wisloff 2007	6	0.96	9	1.9	0.46	8	14.8%	4.10 [3.40, 4.80]
Total (95% CI)			100			106	100.0%	1.60 [0.18, 3.02]

Heterogeneity: Tau^2 = 3.41; Chi^2 = 47.23, df = 8 (P < 0.00001); I^2 = 83%
Test for overall effect: Z = 2.22 (P = 0.03)

Pattyn N. et al. Sports Med 2014

High-Intensity Interval Training in Patients With Heart Failure With Reduced Ejection Fraction

261 Pt, NYHA II-III, EF <35%

Randomization 1:1:1

Moderate Continuous Training

70% HF$_{max}$, 3x47 min/Wk
BORG RPE 11-14

Aerobic Interval Training

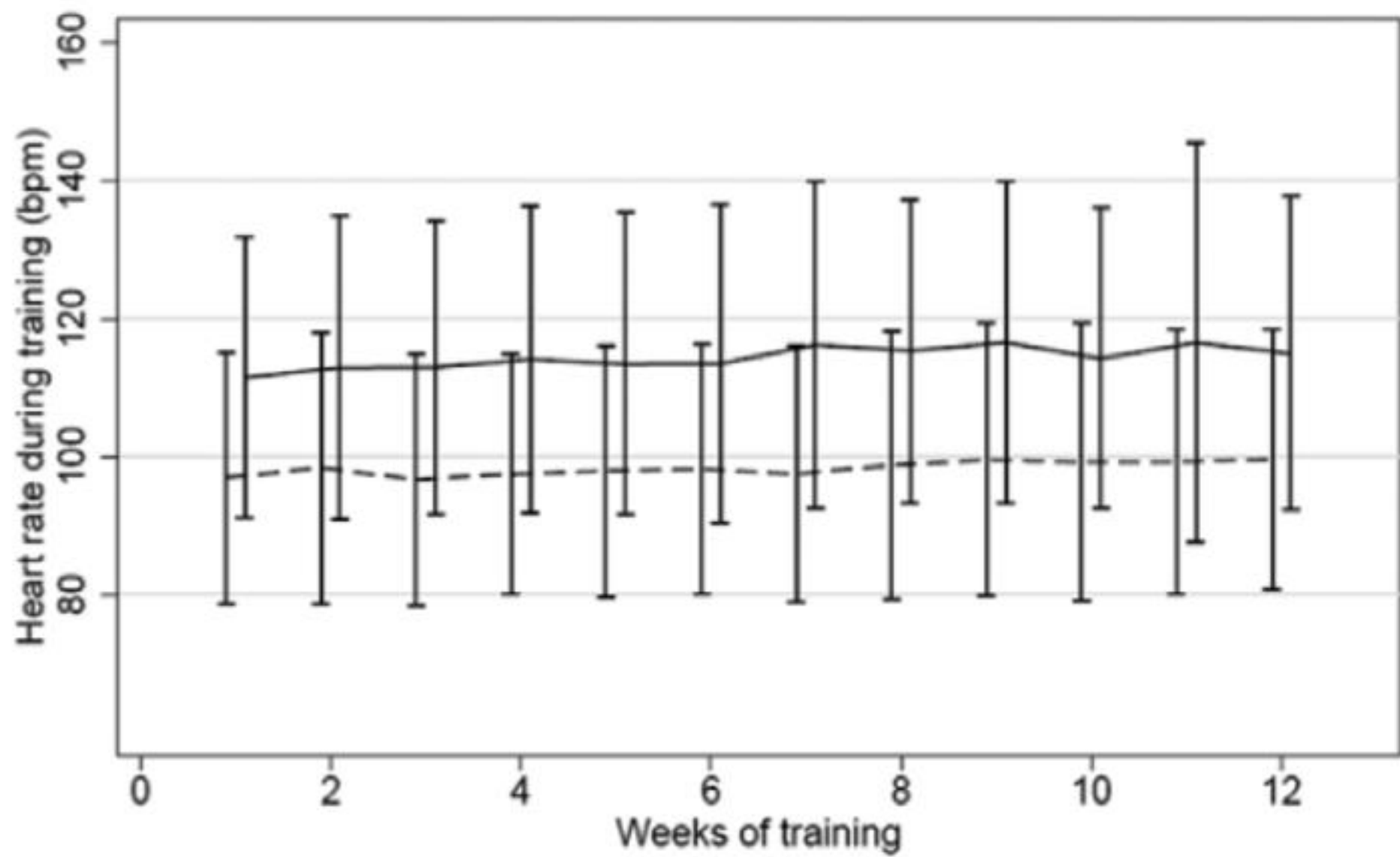95% HF$_{max}$, 3x38 min/Wk
BORG RPE > 15

Control

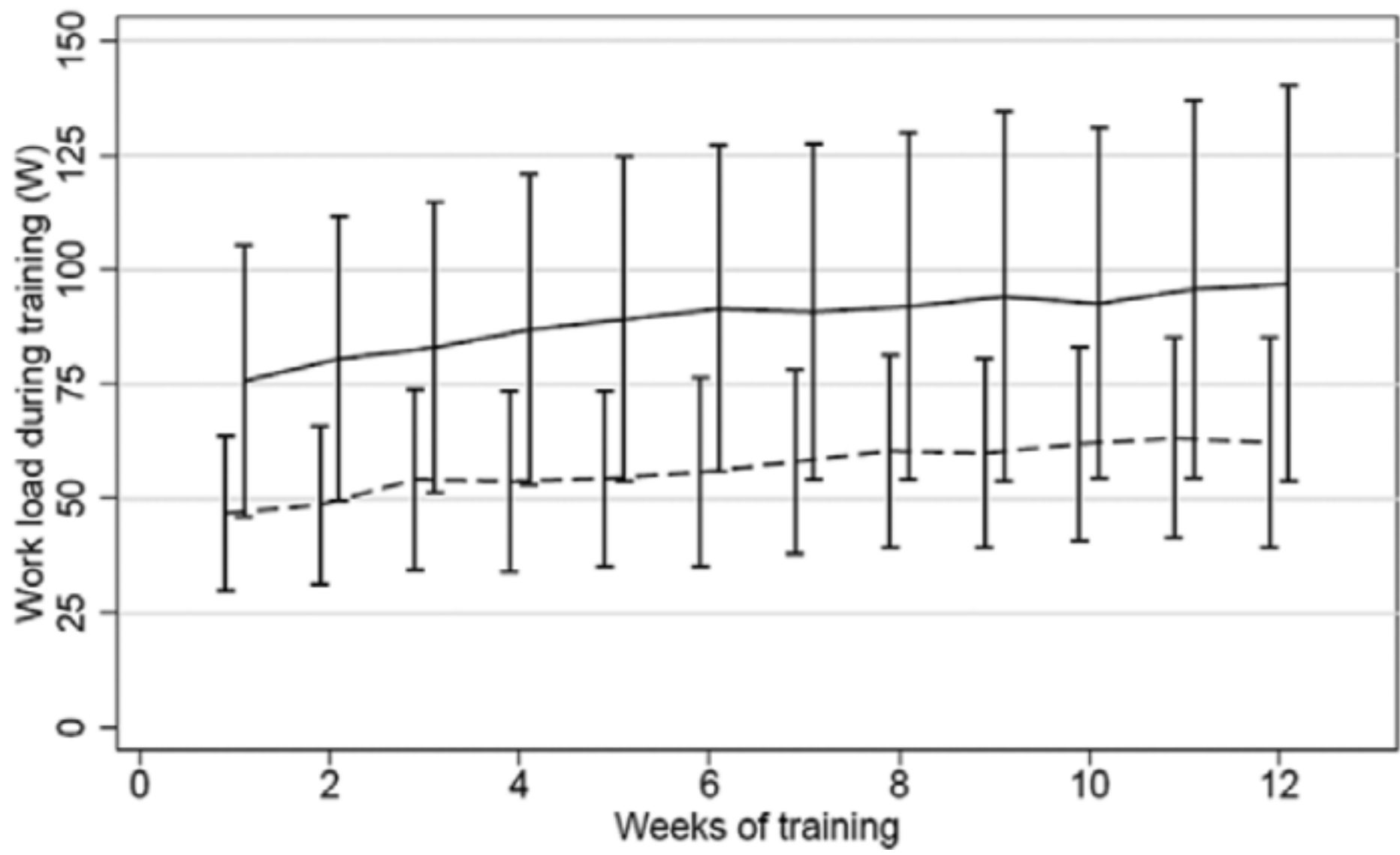70% HF$_{max}$, 1x/3 Wk
„standard advice"

Table 1. Patient Characteristics at Baseline

Characteristics	RRE (n=73)	MCT (n=65)	HIIT (n=77)
Age, y	60 (55–65)	60 (58–65)	65 (58–68)
Women, n (%)	14 (19)	12 (19)	14 (18)
Heart failure <12 mo, n (%)	14 (19)	7 (11)	14 (18)
NYHA class, n (%)			
II	54 (74)	41 (63)	55 (71)
III	19 (26)	24 (37)	22 (29)
Left ventricular ejection fraction, %	30 (28–32)	29 (26–32)	29 (26–31)
Ischemic origin, n (%)	41 (56)	39 (60)	46 (60)
Previous myocardial infarction	32 (44)	36 (55)	44 (57)
Previous CABG	17 (23)	14 (22)	20 (26)
Previous PCI	33 (45)	23 (35)	32 (42)
Device therapy, n (%)			
Pacemaker	2 (3)	0 (0)	2 (3)
Implantable cardioverter-defibrillator	31 (43)	38 (59)	27 (35)
Cardiac resynchronization therapy	3 (4)	1 (2)	1 (1)
Atrial fibrillation, n (%)			
Chronic	6 (8)	8 (12)	14 (18)
Paroxysmal	13 (18)	5 (8)	11 (14)
History of hypertension, n (%)	36 (49)	24 (37)	22 (29)
History of diabetes mellitus, n (%)	14 (19)	21 (32)	16 (21)
History of COPD, n (%)	4 (6)	8 (12)	4 (5)
Current smoking, n (%)	35 (48)	32 (49)	38 (49)
Alcohol drinks per week, n	1 (1–2)	2 (1–3)	1 (1–2)
Medications, n (%)			
ACE inhibitor/ARB	70 (96)	60 (92)	71 (92)
β-Blocker	71 (97)	61 (94)	73 (95)
Aldosterone receptor antagonist	39 (53)	34 (52)	49 (64)
Diuretic	51 (70)	49 (75)	58 (75)
Digoxin or digitoxin	6 (8)	8 (12)	17 (22)
Statin	45 (62)	47 (72)	50 (65)
Body mass index, kg/m^2	27.7 (25.7–28.3)	27.5 (26.6–29.7)	27.6 (26.3–28.7)
Systolic blood pressure, mm Hg	120 (116–124)	119 (112–122)	115 (110–120)
Diastolic blood pressure, mm Hg	75 (70–80)	73 (70–80)	71 (70–87)
NT-proBNP, ng/L	895 (635–1110)	976 (725–1348)	1052 (837–1472)

Ellingsen O. et al. Circulation 2017

Table 2. Main Echocardiography and Cardiopulmonary Testing Measures at Baseline, 12 weeks, and 52 Weeks With Unadjusted Changes

	RRE (n=73)			MCT (n=65)			HIIT (n=77)		
	Baseline	12 wk	52 wk	Baseline	12 wk	52 wk	Baseline	12 wk	52 wk
LVEDD, mm	68 (67 to 69)	69 (65 to 71)	66 (63 to 67)	69 (66 to 72)	67 (65 to 70)	64 (61 to 70)	68 (65 to 70)	63 (62 to 68)	63 (62 to 66)
LVEF, %	30 (28 to 32)	28 (27 to 30)	28 (27 to 32)	29 (26 to 32)	27 (25 to 31)	33 (26 to 37)	29 (26 to 31)	31 (29 to 31)	28 (26 to 32)
Vo_{2peak}, mL·kg^{-1}·min^{-1}	18.4 (16.8 to 19.6)	17.4 (15.7 to 19.8)	18.2 (15.8 to 20.0)	16.2 (15.3 to 18.7)	17.0 (15.7 to 19.6)	16.4 (15.0 to 18.6)	16.8 (15.8 to 17.8)	18.2 (16.3 to 20.0)	17.1 (15.5 to 18.6)
NT-proBNP, ng/L	895 (635 to 1110)	821 (594 to 1079)	626 (419 to 1116)	976 (725 to 1348)	821 (580 to 1169)	688 (544 to 1021)	1052 (837 to 1472)	909 (722 to 1484)	813 (585 to 1615)
Change		Baseline to 12 wk	Baseline to 52 wk		Baseline to 12 wk	Baseline to 52 wk		Baseline to 12 wk	Baseline to 52 wk
LVEDD, mm		0.0 (0.0 to 2.0)	−2.0 (−4.0 to 0.0)		−1.0 (−2.0 to 1.0)	−3.0 (−7.0 to −1.4)		−2.0 (−3.6 to −1.0)	−3.0 (−5.0 to −1.0)
LVEF, %		−0.6 (−2.4 to 1.4)	1.1 (−0.8 to 3.0)		0.7 (−1.8 to 2.6)	0.7 (−1.5 to 4.4)		1.7 (0.0 to 4.5)	−0.2 (−3.1 to 2.8)
Vo_{2peak}, mL·kg^{-1}·min^{-1}		−0.1 (−0.9 to 0.4)	−0.4 (−1.3 to 0.4)		1.1 (0.5 to 1.7)	1.2 (−0.2 to 1.4)		0.9 (0.0 to 1.4)	0.1 (−0.4 to 1.0)
NT-proBNP, ng/L		9 (−43 to 112)	−25 (−108 to 76)		2 (−91 to 97)	−101 (−130 to 30)		19 (−76 to 129)	112 (−24 to 236)

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A

Heart rate during training (bpm)

Weeks of training

- - - - MCT ——— HIIT

⊢———⊣ Mean (SD)

B

… in sintesi…

➤ Change in LDD from baseline to 12 weeks was not different between HIIT and MCT.

➤ There was also no difference between HIIT and MCT in VO2peak, but both were superior to RRE.

➤ Serious adverse events were not different during supervised intervention or at follow-up at 52 weeks (HIIT, 39%; MCT, 25%; RRE, 34%; P=0.16).

➤ **Training records showed that 51% of patients exercised below prescribed target during supervised HIIT and 80% above target in MCT.**

➤ **However, none of these changes was maintained at follow-up after 52 weeks.**

Limiti degli studi

- Eterogeneità del campione
- Eterogeneità dei protocolli per modo, frequenza di training
- Protocollo più studiato: «norvegese» (si veda dopo)
- Durata comunque «breve»: 3-4 mesi.
- Follow-up (adesione) di lungo termine.