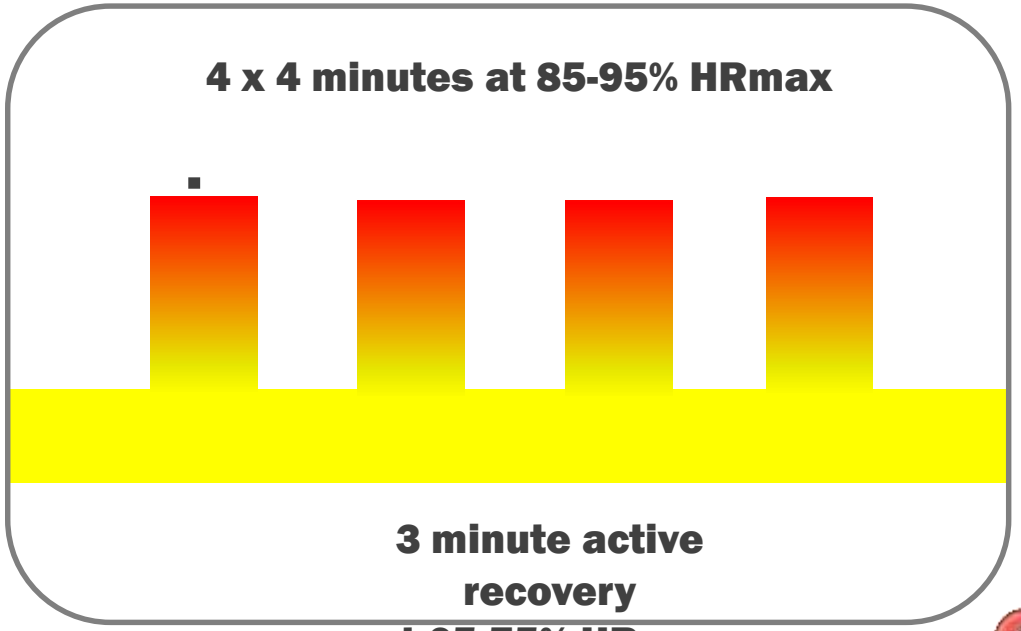
Clinical Considerations of High Intensity Interval Training (HIIT)

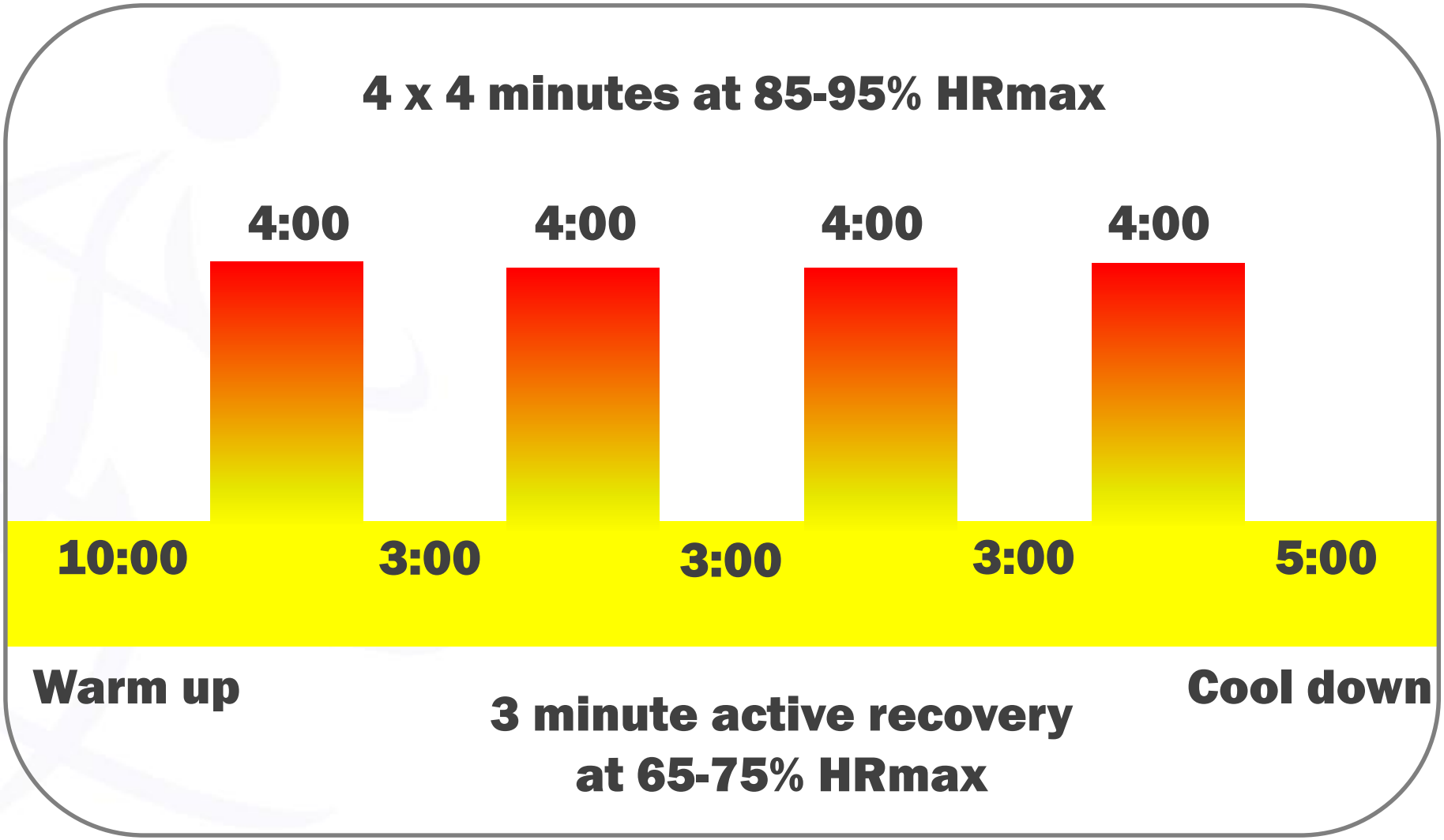
Jenna Taylor
Exercise Physiologist & Dietitian – The Wesley Hospital
PhD Candidate – The University of Queensland

What is High Intensity Interval Training?

Alternating periods of anaerobic exercise with periods of lower intensity or no exercise



Commonly used 4 x 4 HIIT Protocol



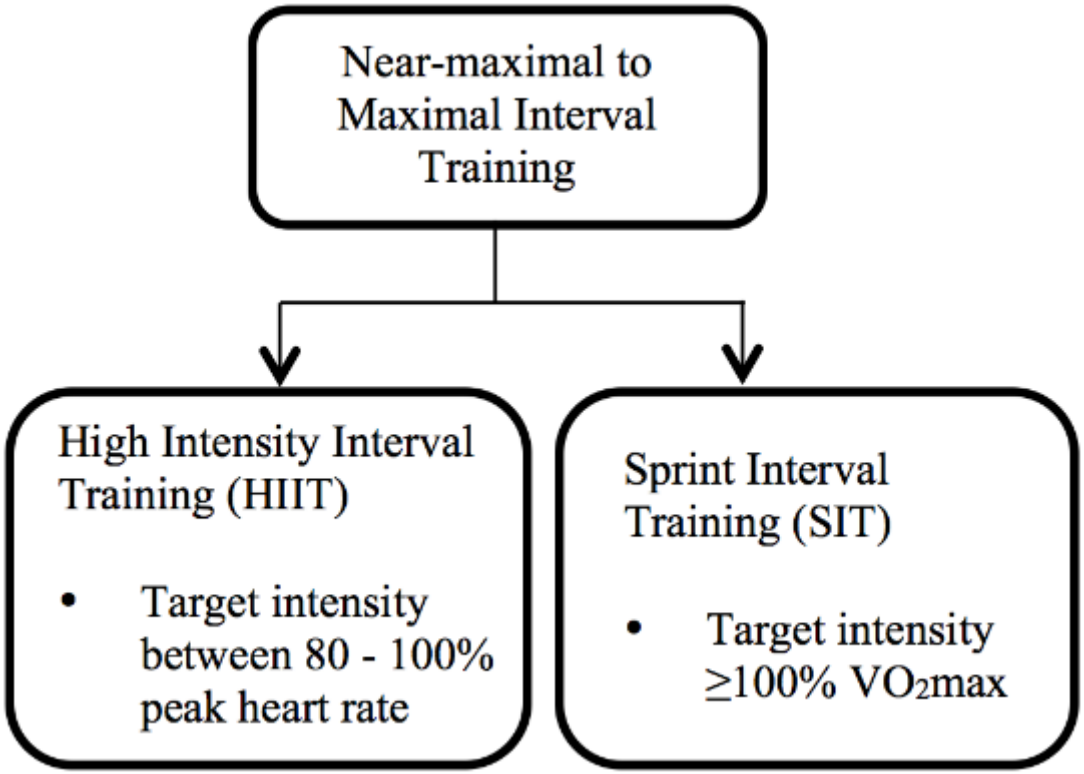
43 mins/session

Sprint Interval Training

Sprint Interval Training

Sprint Interval Training

High Intensity Interval Training
vs
Sprint Interval Training

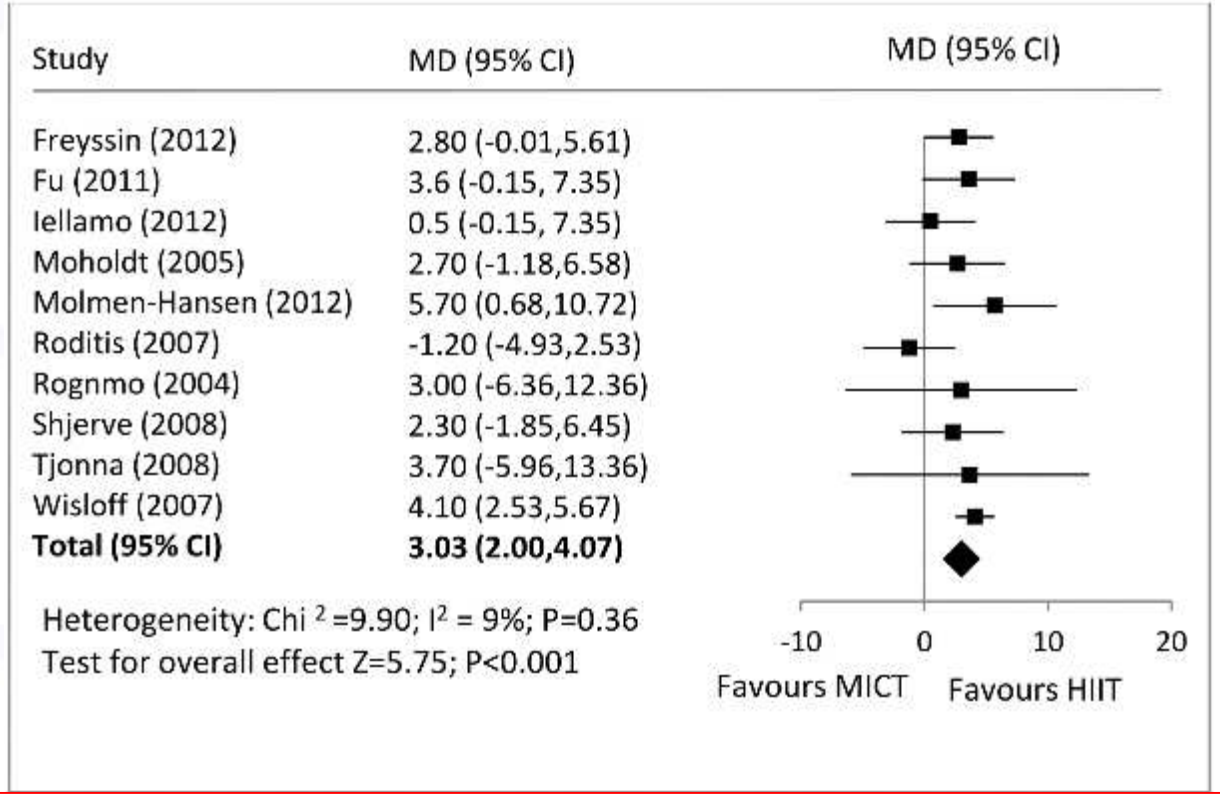


Weston, Wisloff and Coombes, Br J Sports Med., 2014 Aug;48(16):1227-34.

HIIT is relative to the patient.

High Intensity Interval Training

HIIT Doubles Cardiorespiratory Fitness



HIIT increases VO_2peak by 19.4% compared to moderate intensity 10.9%

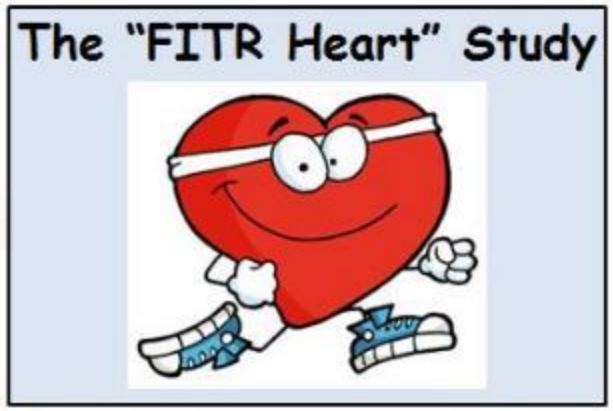
Equivalent to ~ 10-20% greater reduction from HIIT in risk of death over 8 years

Weston, Wisloff and Coombes, British Journal of Sports Medicine, Published Online First: [23 Oct, 2013]

AIM

To clinically translate **High Intensity Interval Training (HIIT)** into a **real world** hospital-initiated **cardiac rehabilitation program**, **using subjective measures of exercise intensity.**

Feasibility, Safety, Adherence, and Efficacy of High Intensity Interval Training for Rehabilitation in Coronary Heart Disease



Stage	Timeframe	Weekly Exercise Training	Level of support
Stage 1	1 month	Hospital Cardiac Rehab Program = 2 x supervised sessions + 1 home-based session	Supervised exercise classes
Stage 2	2 months	Home-based Program ≥ 3 x home-based sessions	Routine support
Stage 3	9 months	Maintenance Program ≥ 3 x home-based sessions	No routine support

Screening Process

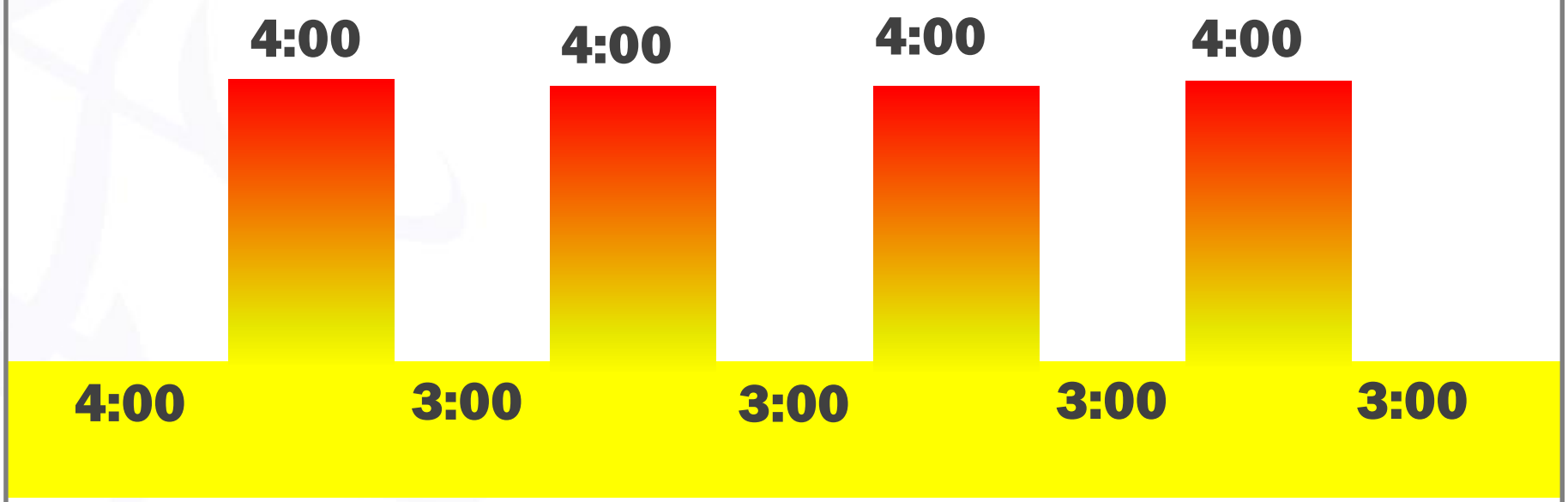
- Angiographically proven CAD
- ≤ 80 years old
- Screened by study medical advisor for eligibility
- Treating cardiologist informed of their patient's participation, with opportunity to exclude involvement
- Baseline maximal exercise test supervised by medical doctor.

Absolute Exclusion Criteria

- < 4 weeks following ACS or CABG
- <3 weeks following PCI
- Obstructive left main artery disease
- Unstable angina
- Uncontrolled cardiac arrhythmia
- Acute endocarditis, myocarditis or pericarditis
- Moderate to severe aortic stenosis
- Decompensated heart failure
- Acute pulmonary embolism, or deep vein thrombosis
- Aortic dissection
- Higher degree heart block
- Hypertrophic obstructive cardiomyopathy
- Recent stroke or transient ischemic attack
- Uncontrolled diabetes
- Acute or chronic renal failure
- Pulmonary fibrosis or interstitial disease
- Severe neuropathy

Our Modified HIIT Protocol

4 x 4 minutes at RPE 15-18 (Hard to Very Hard)
Various exercise machines



3 minute active recovery at RPE 11-13
(Fairly light to Somewhat hard)

32 mins/session

METHODS

Baseline Testing

Cardiorespiratory Fitness (VO2peak)

HR Target Zone Considerations

HR_{max} is not always achieved during maximal exercise test

HR target zone would be affected if:

- Medication dose changed, OR
- Variation existed between the time of training and exercise testing

Exercise Training at 12pm

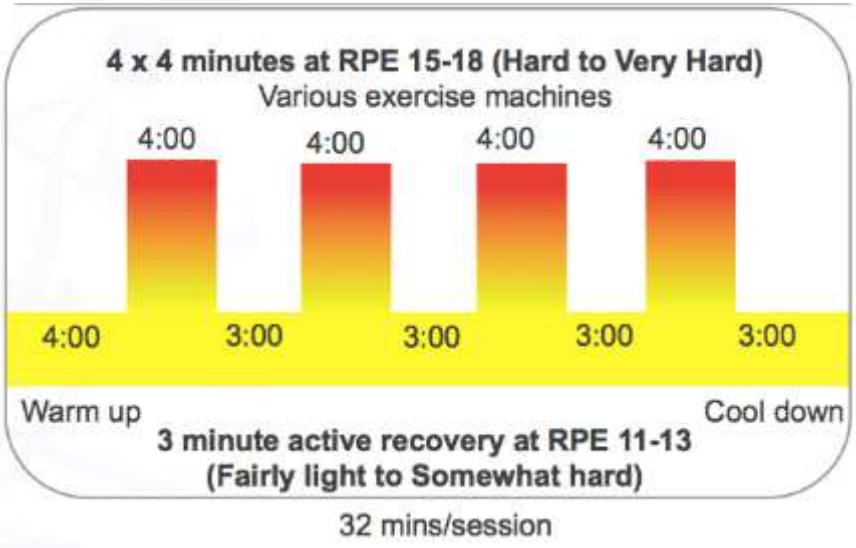
using HRpeak from 9am test

would only achieve a training HR of 77-85% HRmax

RPE-Based HIIT protocol should be used to validate HR training zone

Validation of HR Target Zones

Validate HR target zone during exercise training
Start 4 minute high intensity interval at RPE 15 (Hard)
Finish high intensity interval at RPE 17-18 (Very Hard)
Check and record HR throughout using HR monitor
Allow 2 minutes (halfway) to reach HR target zone



32 mins/session

Indications of an inaccurate HR target zone
- Exercising HR is above HRmax
- Exercising HR is below target HR zone but RPE is 15-18.

Continue using HR target zone
If HR remains in target HR zone during validation, **OR**
If there is an indication of inaccurate HR target zone arises, **go to Calibration**

CALIBRATION
- Repeat maximal exercise test and recalculate HR target zone, OR
- Use RPE to guide intensity

RESULTS – Baseline

Participant Characteristics	HIIT (n= 47)
Age (years)	65 ± 7
VO_2peak (ml/kg/min)	27.7 ± 6.0
BMI (kg/m^2)	28.0 ± 4.0
Males	39
Females	7
Cardiac event / intervention (%)	
Acute coronary syndrome	19
CABG	32
PCI/Stent	49
Medical	17
Other risk factors (%)	
Diabetes	4
Smoking	2

RESULTS – Baseline

Medications	HIIT (%)
B-Adrenergic blockers	40
Statins	98
ACE inhibitor	19
Angiotensin II receptor blockers	34
Calcium channel blockers	4
Antiplatelet agents	
• Aspirin	96
• Other	53

RESULTS – 5 weeks

43 patients completed 4 week HIIT program

98% patients – willing to continue HIIT after 4 weeks

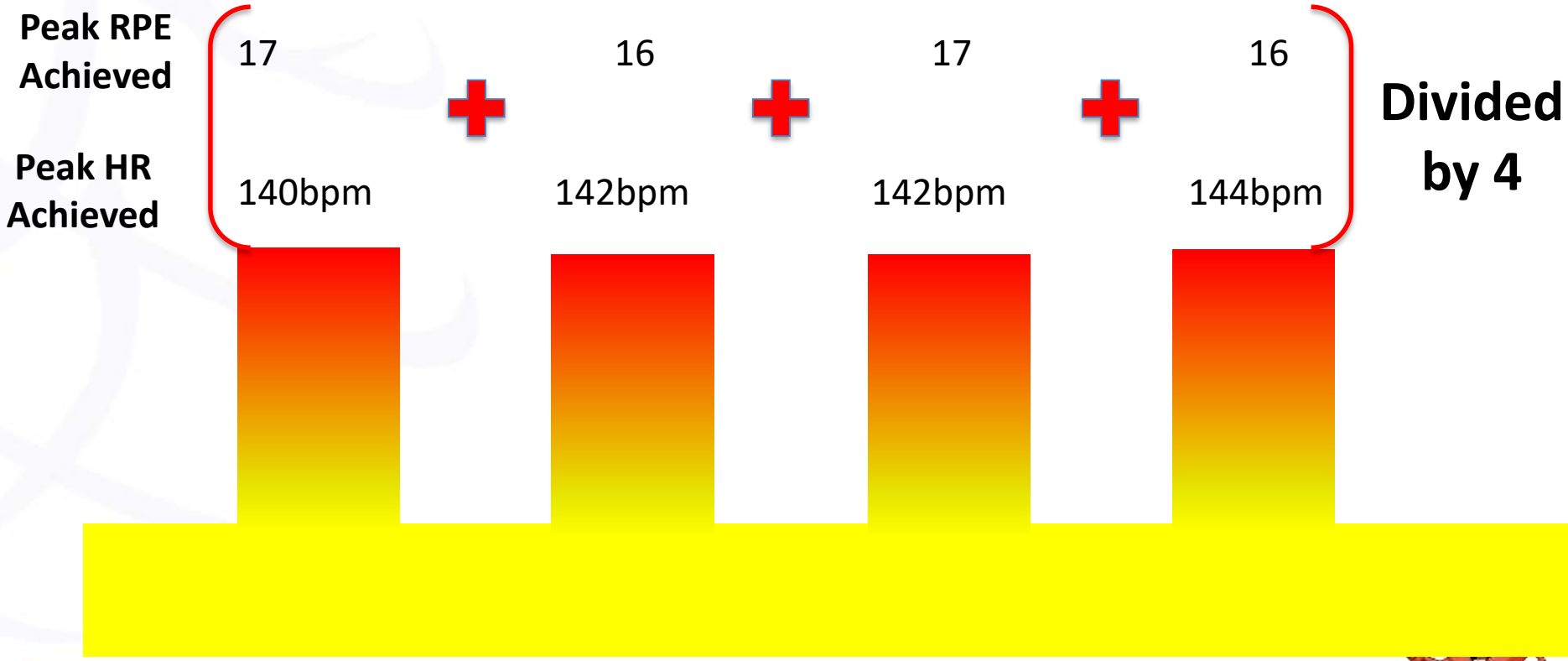
Enjoyment was high - rated as 5.4 out of 7 on likert scale

Adherence to protocol (completion of sessions) = 91 $\pm$ 14%

Adherence to protocol (intensity & duration) = 79 $\pm$ 20 %

RESULTS – Training data

Mean Average Training Data = Average of all 4 intervals over 4 weeks



RESULTS – Training data

Mean Peak Training Data = Average of interval with highest value over 4 weeks

Peak RPE Achieved	17	16	18	17
Peak HR Achieved	140bpm	142bpm	142bpm	144bpm

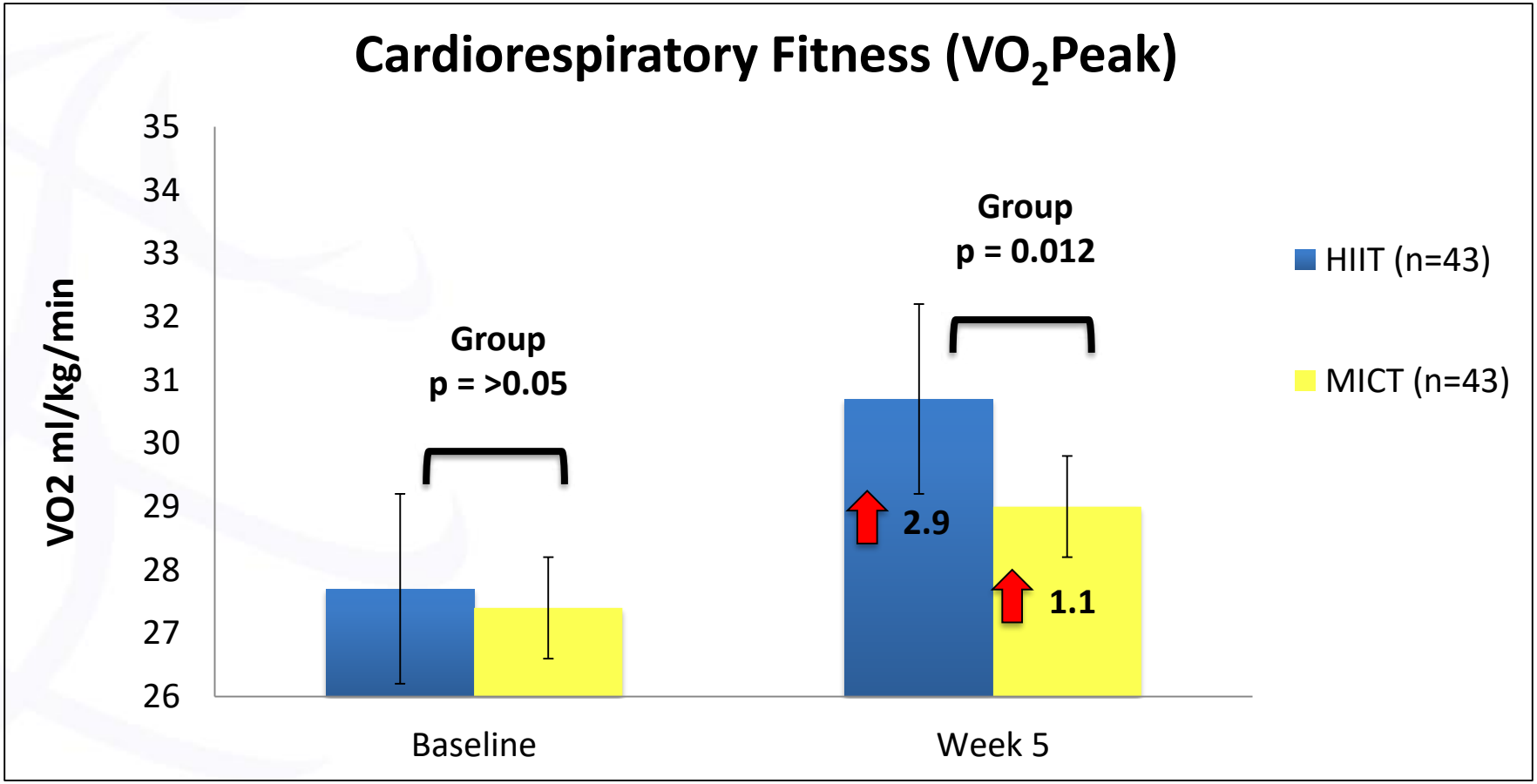
RESULTS – Training RPE data

Mean Average Training Data = Average of all 4 intervals over 4 weeks

Mean Peak Training Data = Average of interval with highest value over 4 weeks

Training Data	Mean Average (4 HIIT intervals)	Mean Peak (highest HIIT interval)
Training RPE	16 ± 1	17 ± 2

RESULTS – VO2peak



HIIT = +2.9 ± 3.5 ml/kg/min; MICT = 1.1 ± 0.0 ml/kg/min

RESULTS

Correlation with Change VO_{2peak}	Correlation Coefficient	P Value
Average Training RPE	.135	0.22
Peak Training RPE	.101	0.35

Correlation with Change VO_{2peak}	Correlation Coefficient	P Value
Average Training HR	.277*	0.01
Peak Training HR	.262*	0.01

RESULTS – Training HR data

Training Data	Mean Average (4 HIIT intervals)	Mean Peak (Highest interval)
Training HR (bpm)	93 ± 6	99 ± 7
Number of participants Below target HR (<85%HR_{max})	4, (9%)	0, (0%)

44% patients achieved a higher HR on follow-up exercise test

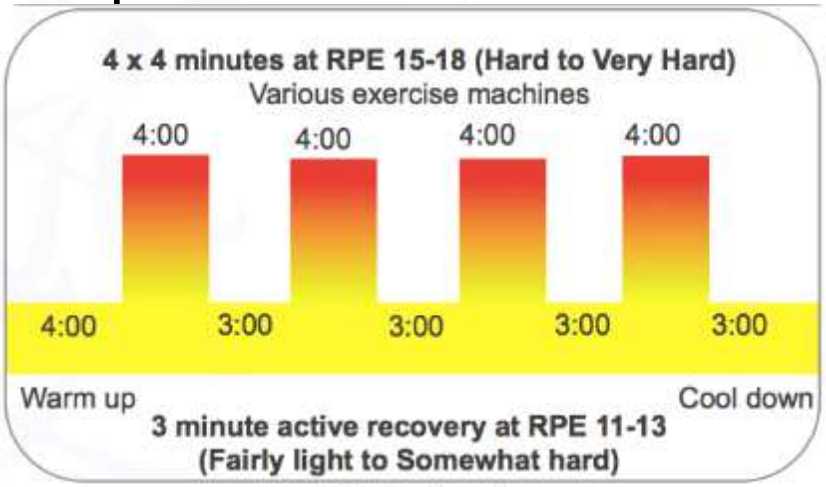
ADJUSTED Training Data	Mean Average (4 HIIT intervals)	Mean Peak (Highest interval)
Training HR (bpm)	90 ± 6	96 ± 7
Number of participants Below target HR (<85%HR_{max})	8 (18%)	2 (5%)

Guidelines for HIIT Prescription

STEP 1: **Measure or Estimate HRmax**
From maximal exercise test or prediction equation

STEP 2: **Calculate HR target zone**
Establish zone from 85 to 95% HRmax

STEP 3: **Validate HR target zone during exercise training**
Start 4 minute high intensity interval at RPE 15 (Hard)
Finish high intensity interval at RPE 17-18 (Very Hard)
Check HR throughout using HR monitor
Allow 2 minutes (halfway) to reach HR target zone



32 mins/session

STEP 4A: **Continue using HR target zone**
If HR remains in target HR zone during validation.
OR if there is an indication of inaccurate HR target zone arises, go to Step 4B.

Supplementary Information

Abbreviations
- HR = Heart Rate;
- RPE = Rating of Perceived Exertion (6-20 BORG scale)

Formulae for estimating HRmax
- If not taking beta blocker = 211 – (0.64 x age)[7]
- If taking beta blocker = 164 – (0.7 x age)[8]

Reasons for inaccurate HR target zone
- Maximal exercise testing did not provide HRmax
- Medications affecting HR (beta blockers) have variable HR response depending on dosage, and time of exercise

For cardiac patients, extend warm up and cool down ≥ 3 minutes

Monitoring during HIIT

- Record highest HR achieved during each high intensity interval
- Ask for highest RPE during each high intensity interval
- Monitor for symptoms (see Figure 2) before, during, and after.
- Measure blood pressure during final 2 minutes of the high intensity interval (initially during the 1st interval to check for hypertensive response)

Indications of an inaccurate HR target zone
- Exercising HR is close to or above HRmax (from STEP 1)
- Exercising HR is below target HR zone but RPE is 15-18.

STEP 4B: **CALIBRATION**
Repeat maximal exercise test and recalculate HR target zone, OR
Estimate new HRmax and recalculate HR target zone, OR
Use RPE to guide intensity

Clinical Considerations for HIIT

Initial Assessment

- Presenting medical condition
- Medical history (check for exclusions)
- Co-morbidities (e.g. diabetes, hypertension)
- Medication regimen (including dose and timing)
- Relevant clinical data (e.g. resting blood pressure and heart rate, fasting blood glucose, oxygen saturation)
- Treating physicians and general practitioner
- Current or previous physical activity level
- Factors that may impact exercise participation (e.g. injury)

Screening tool may be useful (ACSM Preparticipation screening algorithm[9])

Monitoring Checklist

- How is the patient feeling today
- Medical updates or changes to health status
- Recent symptoms (e.g. angina, light-headedness)
- Prescribed medications taken within the past 24 hours
- Medication regimen changes (dose / timing)
- Resting blood pressure and heart rate
- Resting and post-exercise blood glucose in patients taking insulin or other oral hypoglycemic agents
- Monitor dehydration pre and post (>2% drop from usual bodyweight) in patients at risk of electrolyte imbalance (e.g. kidney disease)

Absolute Contraindications (adapted from Fletcher et al)

- Obstructive left main artery disease
- Unstable angina
- Uncontrolled cardiac arrhythmia
- Acute endocarditis, myocarditis or pericarditis
- Moderate to severe aortic stenosis
- Decompensated heart failure
- Acute pulmonary embolism, or deep vein thrombosis
- Aortic dissection
- Higher degree heart block
- Hypertrophic obstructive cardiomyopathy
- Recent stroke or transient ischemic attack
- Uncontrolled diabetes
- Acute or chronic renal failure
- Pulmonary fibrosis or interstitial disease
- Severe neuropathy
- Recent myocardial infarction (< 4 weeks), coronary artery bypass surgery (<4 weeks), or percutaneous intervention (<3 weeks)

Indications for avoiding HIIT

- Feeling unwell
- Current angina, light-headedness, or dyspnea
- Resting blood pressure > 200/110mmHg
- Hypoglycemic event in the past 24hours that required assistance from another individual to treat the event
- Blood glucose <4.0mmol/L
- Blood glucose >15.0mmol/L with symptoms of hyperglycemia
- Presence of any atypical arrhythmia (detected via telemetry or pulse)

Indications for ceasing HIIT

- Symptoms such as angina, dyspnea, light-headedness, confusion, or signs of poor perfusion.
- Rise in blood pressure > 250/115mmHg
- Drop in systolic blood pressure >10mmHg from baseline during high intensity interval.
- Slowing heart rate with higher workload or development of any atypical arrhythmia

Medical Clearance

- Medical clearance (from medical specialist or general practitioner) should be sought for all patients with clinical conditions prior to commencing HIIT.
- For patients post surgery or percutaneous intervention, clearance should be sought from the respective surgeon or interventionalist.

CRExPAH - Centre for Research on Exercise, Physical Activity & Health

CONCLUSIONS

HIIT is a potent stimulus and time efficient way to improve fitness

HIIT can be effectively delivered using RPE

HR target zones are still important

HIIT has a high adherence and enjoyment rate

HIIT well accepted in this population – 98% found it feasible to continue

Another tool in the toolbox

ACKNOWLEDGMENTS

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