HIIT: Current evidence and future application in cardiovascular rehabilitation

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Conflicts of Interest: None
Outline

• Brief background of HIIT

• The aerobic fitness benefits(?) of HIIT

• HIIT in cardiac populations

• Emerging UK evidence
What is HIIT?

Repeat bouts of short duration high intensity exercise interspersed with short duration low intensity active recovery periods

Some disagreement in intensity zones - typically submaximal efforts >80% of maximal HR/>80 peak work rate

Variations in exercise volume/programme length
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920s</td>
<td>Reported as early as the 1920s in athletic populations</td>
</tr>
<tr>
<td>1954</td>
<td>Sir Rodger Bannister used HIIT during his lunch break - achieved the 4 minute mile</td>
</tr>
<tr>
<td>1960's</td>
<td>Peer-reviewed literature begins to emerge in healthy/athletic populations</td>
</tr>
<tr>
<td>1970/80's</td>
<td>Evidence for interval and high intensity interval training in clinical populations begins to emerge</td>
</tr>
<tr>
<td>1996</td>
<td>Katerina Meyer found that interval training in CHF was safe – Assessed catecholamine, cardiac/metabolic stress, &amp; dyspnoea - CHF patients can tolerate HIIT.</td>
</tr>
<tr>
<td>Today</td>
<td>A vast volume of literature on the efficacy of HIIT in health and disease</td>
</tr>
</tbody>
</table>
Is it safe?

The likelihood of a cardiac event in high risk individuals appears to be low when conducting either moderate, or high intensity exercise.

Table 1. The number of patients, exercise-hours and the corresponding number of cardiovascular events associated with moderate- and high-intensity exercise, respectively.

<table>
<thead>
<tr>
<th>Center</th>
<th>Patients (n)</th>
<th>Total training (hours)</th>
<th>Moderate-intensity (hours)</th>
<th>High-intensity (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ålesund</td>
<td>775</td>
<td>25 720(^1)</td>
<td>15 232</td>
<td>10 488(^1)</td>
</tr>
<tr>
<td>Feiring</td>
<td>2629</td>
<td>85 208(^2)</td>
<td>63 032(^1)</td>
<td>22 176(^1)</td>
</tr>
<tr>
<td>Roros</td>
<td>1442</td>
<td>64 892</td>
<td>51 192</td>
<td>13 700</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4846</strong></td>
<td><strong>175 820</strong></td>
<td><strong>129 456</strong></td>
<td><strong>46 364</strong></td>
</tr>
</tbody>
</table>

Event rates:

- Cardiac arrest, fatal: 1, 0
- Cardiac arrest, non-fatal: 0, 2
- Myocardial infarction: 0, 0

Risk of events: 1/58 607, 1/129 456, 1/23 182
**Is it Effective?**

- $VO_{2\text{max}}$, insulin sensitivity and endothelial function all appear to improve to a greater extent during HIIT, compared to MISS.

**Findings can be variable**

- Improvements in muscle oxidative capacity/mitochondrial volume/quality.

- Improved endothelial function/increased NO.

- Greater depletion of muscle glycogen stores leading to enhanced glucose uptake $\rightarrow$ improve insulin sensitivity.
Is it Really Effective?

The effects of low vol. HIIT appear to favour less fit populations.

Favours HIIT 0.51 L/min (43 to 0.60 L/min) up to 0.9 L for longer studies.

There is no definitive consensus on whether HIIT is superior to *Well Prescribed* endurance exercise training apparently populations.

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**Higher Vol.** – Bacon ‘13

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**Lower Vol.** – Weston ‘14

<table>
<thead>
<tr>
<th>Effect on VO$\text{$_{2max}$}$ (%)</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ±90 % CL</td>
<td></td>
</tr>
<tr>
<td>Sedentary males</td>
<td>10.0 ± 5.1</td>
</tr>
<tr>
<td>Sedentary females</td>
<td>7.3 ± 4.8</td>
</tr>
<tr>
<td>Active non-athletic males</td>
<td>6.2 ± 3.1</td>
</tr>
<tr>
<td>Active non-athletic females</td>
<td>3.6 ± 4.3</td>
</tr>
<tr>
<td>Athletic males</td>
<td>2.7 ± 4.6</td>
</tr>
<tr>
<td>Controls</td>
<td>1.2 ± 2.0</td>
</tr>
</tbody>
</table>

Weston et al (2014)
The effects of short-term HIIT also favour less fit populations

Batacan '17

Similar to VO$_{2\text{peak}}$, HIIT appears more effective at improving cardiometabolic health when individuals are unfit or sedentary
## Adaptations in sedentary individuals

<table>
<thead>
<tr>
<th>Type</th>
<th>Frequency</th>
<th>Time</th>
<th>Intensity</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISS</td>
<td>Exercise 3 x p/week for 8 weeks</td>
<td>Exercise progressed from 20 to 35 minutes</td>
<td>~60% PPO</td>
<td>VO\textsubscript{2peak} - MISS 9% : HIIT 15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>a-VO\textsubscript{2} diff – MISS ↑: HITT ↑</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Q\textsubscript{max} : MISS ~ : HITT ↑</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>VO\textsubscript{2} Kinetics - MISS~ : HIIT: ↑</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exhaustion Time - MISS↑: MISS↑ ↑</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Capillary/Fibre R - MISS↑: MISS↑</td>
</tr>
<tr>
<td>HIIT</td>
<td></td>
<td></td>
<td>4 min low / 1 minute 90% PPO</td>
<td></td>
</tr>
</tbody>
</table>

**Effect of interval versus continuous training on cardiorespiratory and mitochondrial functions: relationship to aerobic performance improvements in sedentary subjects**

Frédéric N. Daussin, Joffrey Zoll, Stéphane P. Dufour, Elodie Ponsot, Evelyne Lonsdorfer-Wolf, Stéphane Doutreleau, Bertrand Mettauer, François Piquard, Bernard Geny, and Ruddy Richard

1CHRU of Strasbourg, Physiology and Functional Explorations Department, Civil Hospital, Strasbourg, France and University Louis Pasteur, Faculty of Medicine, Physiology Department, Strasbourg, France; and 2Cardiology Department, Civil Hospital, Colmar, France
So what might this mean for cardiovascular rehabilitation programmes?
Is HIIT Effective in Cardiac Populations?

Mean difference favours HIIT by 3.03 mL/kg/min (95% CI 2.00 to 4.07; p<0.001)

Six out of 10 studies conducted by the same research group

Only 273 patients included

Other systematic reviews/meta-analyses show similar results

Heart Failure Only

Mean difference favours HIIT by 2.14 mL/kg/min (95% CI 0.66 to 3.63)
The Clinical Significance?

$\text{VO}_{2\text{peak}}$ is one of the strongest clinical prognosticators. Improvements in $\text{VO}_{2\text{peak}}$ are consistently associated with improved survival:

- **Kodama \textit{et al.} (2009):** ~103,000 patients; demonstrate 1 MET improvement in aerobic fitness confers 13% survival advantage

- **Myers \textit{et al.} (2002):** ~6200 patients: 1 MET improvement in aerobic fitness confers 12% survival advantage

- **Vanhees \textit{et al.} (1995):** 1% improvement in exercise training induced $\text{VO}_{2\text{peak}}$ confers a 2% survival advantage in patients with CHD
Low aerobic fitness indicates poor cardiometabolic health - Unpublished

- Lean body mass
- Android/gynoid ratio
- Ventilatory anaerobic threshold
- Heart rate recovery (1, 2, 3 and 6 minutes)
- Haemoglobin/Haematocrit
- BMI
- Waist to hip ratio
- Left ventricular ejection fraction
- Previous MI
- Lipid profiles
- VE/VCO₂ slope
- Oxygen uptake efficiency slope
- Resting heart rate
- hs-CRP
- Glucose (non-fasting)
- NT-proBNP
The Role of HIIT in Cardiac Populations

Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease
Cochrane Systematic Review and Meta-Analysis

Changes in cardiorespiratory fitness in cardiac rehabilitation patients: A meta-analysis

Rehabilitation after myocardial infarction trial (RAMIT): multi-centre randomised controlled trial of comprehensive cardiac rehabilitation in patients following acute myocardial infarction

Cardiorespiratory fitness changes in patients receiving comprehensive outpatient cardiac rehabilitation in the UK: a multicentre study

The minimum clinically important improvement in the incremental shuttle walk test following cardiac rehabilitation
The Role of HIIT in Cardiac Populations

- Evidence for the application of HIIT in clinical practice is evolving

- There remains a lack of high quality ‘pragmatic’ real-world evidence

- A major research/logistical challenge in the UK? Prescribing HIIT when maximal exercise testing is not widely available.
Pragmatic multi-centre RCT – 510 patients

Eight weeks – 2 x per week

10 x high intensity bouts at 85 - 90% PPO

10 x low intensity bouts at 20 - 25% PPO

Control group – standard care at 40-70% HRR

Assessed following intervention ~8 weeks and at 12 months

Primary outcome measure - \( \text{VO}_2\text{peak} \)

Also assessing other physiological, psychosocial and economic outcomes

@HIITorMISSUK - Study update
@HITorMISSUK

Coventry
Hull
Cardiff

Sept 2016
Sept 2017

Sept 2017

n=102 recruited
4 SAE’s (2 per group)
13 lost to follow-up – 8 HIIT/5 MISS
Have Your Say!

- We would like to understand how UK CR exercise programmes are currently operating.

- At the end of our survey, there is a section relating to the future role that HIIT may have in UK CR programmes.

- We just need one response from each team – Someone directly involved in exercise provision

- [https://northumbria.onlinesurveys.ac.uk/an-evaluation-of-exercise-provision-within-uk-cardiac-reha](https://northumbria.onlinesurveys.ac.uk/an-evaluation-of-exercise-provision-within-uk-cardiac-reha)
Summary

• Compared to MISS, HIIT appears to provide superior health benefits

• Variation in HIIT protocols and magnitude of benefit

• HIIT appears to be safe and effective in cardiac populations – HIIT or MISS UK may provide much needed ‘real-world’ evidence.
Thank You

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References


West RR, Jones DA and Henderson AH. Rehabilitation after myocardial infarction trial (RAMIT): multi-centre randomised controlled trial of comprehensive cardiac rehabilitation in patients following acute myocardial infarction. *Heart* (2012); **98**: 637-644.

