This or That: High Intensity Exercise Training

Kim Radtke MS, RCEP, CCRP, Doctoral Student
Carl Foster, Ph.D., FACSM
Department of Exercise and Sport Science
University of Wisconsin-La Crosse
USA
Exercise is Good for You

- Steady state exercise
  - Increase in VO$_2$max
  - Decrease in morbidity/mortality
High Intensity Interval Training (HIIT): Fartlek (Swedish for Speed Play)

- Athletes have always done “speed work”
- Systematic development
  - Gosta Holmer 1937
- Running (often in the forest) with ‘natural variations in pace’ (defined by terrain)
- Similar pattern to contemporary training pattern of Kenyans
- Hard to track training loading & estimate competitive readiness
Competitive Success With Fartlek

- Gunder Hagg & Arne Anderson
- Legendary series of races
- 1942-1945
- Broke 1 mile record 6 times in 4 years
  - 4:06.2-4:01.4
- Raced each other, rather than breaking 4:00
Systematic Approach to Training: Interval Training

- Freiburg, Germany
  - Fartlek was ‘not precise enough’
  - Late 1930’s
- Runs of 100-400m with rest intervals
  - Run to HR=180 (90%HRmax)
  - Recover to HR=120 (60%HRmax)
  - ? HR measurement accuracy?
  - ? Logic of 180/120
- Premise was that SV was forced high in the recovery period
  - Wrong!!!
- Experiments with doping also began about this same time ???????
Competitive Successes With Interval Training

Emil Zatopek
5x Olympic Gold

Rudolph Harbig
1:46.6 WR  46.0 WR

Josy Barthel
1952 Olympic 1500m

Roger Moens
1:45.7 WR

Roger Bannister
1954 3:59.4 WR
High Intensity Interval Training

Precision Training

- Ability to track progression by faster times for repeats of certain distance
- Ability to translate specific workouts into competitive readiness
  - 10 x 400m on 2:00
  - Average pace=1 mile competitive pace
Elements of HITT

1. Relative intensity (PO) during hard and recovery segments
   - VT, VT2, VO\textsubscript{2}max, MSEC, 170% PPO
2. Length of hard segments
   - 5sec-5 min
3. Length of recovery segments
4. Ratio of hard & recovery segments
   - 1:1, 1:2, 1:3, 1:4
Why Does HIIT Work?

- Controlled RPE
- Recruits Type I & II fibers
- Recruits whole body

Big Signal for adaptation
More total muscle fibers
Type II muscle fibers
Burns glycogen & glucose = glucose disposal
= Metabolic effect
HIIT Gets Popular

How to do effective workouts in limited time

The One-Minute Workout
Science Shows a Way to Get Fit That’s Smarter • Faster • Shorter

With 8 Interval Workouts Plus 4 Microworkouts

Martin Gibala, Ph.D., with Christopher Shulgan

“Persuasively shows just how effective super-short workouts are for increasing both fitness and health.”
—GRETCHEN REYNOLDS, AUTHOR OF
THE NEW YORK TIMES BESTSELLER THE FIRST 20 MINUTES
How Do You Do HIIT Without Killing Someone?
High Intensity Interval Training Causes Large Adaptation in a Short Time in Young Healthy People

- Physical Education students
- **Endurance training**
  - 6 weeks
  - 60 min/day x 5 day/week
  - 70%VO2max

- **HIIT**
  - 6 weeks
  - 4 days/week
    - 7-8 sets 20s @ 170%VO2max
    - 10s recovery between sets
    - 4 minutes total time
  - 1 day/week = 60 min @ 70% VO2max

Big signal + increased muscle fibers + short time = big adaptations
KA Burgomaster Six sessions of sprint interval training increases muscle oxidative potential and cycle endurance capacity in humans *J Appl Physiol* 98: 1985-1990, 2005

Six sessions over 2 weeks
Multiple Wingate Tests on 5 min

Endurance

Muscle Oxidative Capacity
MJ Gibala & SL McGee Metabolic adaptations to short term high-intensity interval training: A little pain for a lot of gain.  
*Exerc Sport Sci Rev 30:58-63, 2008*

- **Very Brief Training Protocols**
  - 2-3 weeks
- **Endurance Training**
  - 70% VO2max
- **HIIT**
  - Multiple Wingate Tests

**COX Activity**

**PGC1-a Gene Expression**

* *
JA Babraj Extremely short duration high intensity interval training substantially improves insulin action in young healthy males. 

- Healthy young men
  - $\text{VO}_2\text{max}=48 \text{ ml/kg}$
- 2 weeks HIIT training
  - 6 sessions
  - 4-6 x 30s/4.5 min recovery
- Insulin sensitivity to glucose challenge improved 23%
- Aerobic cycling performance improved 6%
- HIIT creates substrate for excellent glucose disposal
  - Empty Tank

![Graph showing changes in Glucose, Insulin, and NEFA levels before and after HIIT training.]
Exercise In the Clinical World

- Strict Bedrest pre 1952
- Arm Chair Method 1952
  - Levine
  - 50% reduction in in-hospital mortality
    - Semelweiss hand washing by MDs
- Systematic Aerobic Exercise 1957
  - Hellerstein & Ford
- Marathon Running for Patients 1973
  - Kavanagh
- High Intensity Exercise Training 1973
  - Smolak
Much Further Back in History

- William Heberden, M.D.
- First physician to describe exertional angina pectoris, in 1772
- Described a patient (himself?) with angina who was ‘nearly cured’ after setting himself the task of sawing wood for half an hour daily
- **Sawing wood fits the HIIT model**
  - Inherently high intensity
  - Intermittent
  - Whole body
  - Even the CrossFitters would love this
K Meyer et al.: Interval vs continuous exercise training After CABGS: A comparison of training induced acute reactions with respect to the effectiveness of the exercise methods


- Uncomplicated Post (3-4 wk) CABGS Patients
- 1 wk preliminary mixed training
- 2x daily 1x20+1x25
- 85% HRmax
- 60s/60s

**INT**
- 0.27--1.19 W/kg
- 0.27--1.46 W/kg
- 0.27—1.66 W/kg

**CONT**
- 0.77 W/kg
- 0.95 W/kg
- 1.09 W/kg

![Interval vs Continuous Training in CHD](chart.png)

**Power Output (W/kg)**
- Continuous: 62% PPO
- Interval: 100% PPO

**Graph Notes**
- +21%
- +53%
Secret of the K. Meyer Method

- CHF patients = limited central \( \text{O}_2 \) transport adaptations
- All you can do is ‘give them their legs back’
  - Pick the right PO
    - 50% MSEC
    - 100% Ramp
    - Net intensity <VT
  - Start with 30s/60s
  - If this is too hard, reduce the length of the hard segment, keep the PO up
  - You could ‘bottom up’ the interval training based on continuous training
Stable patients with CHF, CAD & healthy

Steady state cycling @ 70% VO2max

10-15 reps of shoulder press, leg press & biceps curls @ 50% 1RM

LV function responds the same (normally) in all groups

- 21 patients with stable CAD
- Treadmill walking
- 4 min intervals
  - 3 x weekly, 10 weeks
  - 80-90% VO2max
  - 50-60% VO2max

Peak oxygen uptake (VO2peak) before and after aerobic exercise training. Significant differences within groups after training. Increment significantly larger in high intensity group.

- **RCT**
- **Patients with stable post MI CHF**
- **Moderate Continuous Training (70%HRmax)**
- **Aerobic Interval Training (3-4 x 4 min/4min @95%HRmax)**

- Patients with metabolic syndrome
- RCT:
  - Con
  - MICE (70%)
  - AIT (90%)
- 3x weekly, 16 weeks

MS=Central Obesity, Hypertension, High TG, Low HDL-c, Glucose Intolerance=early CHD
Obese sedentary men: BMI=31, Age=32

2 Weeks Sprint Interval Training
- Wingate Test with 4.5 min recovery
- 3 sessions/week
- 4-6 repeats

VO2max 2.98-3.23 l/min

Wingate power 579-600W

Insulin sensitivity 4.34-5.35

Not a “training effect”.
Works when glycogen stores are empty!
What if There is No Testing?

Bottom Up HIIT Prescription

Bottom Up HIIT Prescription With Progression

LP-1 Talk Test Intensity
RPE=13
Conclusions #1

- **YES**
  - You can get BIG training responses from almost any variety of HIIT
    - Aerobic
    - Anaerobic
    - Body composition
  - **Metabolic secret**
    - Recruit Type II muscle fibers
    - Glycogen depletion
  - Time requirement may be fairly small
  - Account for warm up and cool down
  - 10-20% of training time as HIIT
    - 5 min wu
    - 10 x 30s/60s @ 100% PPO/50W
    - 5 min cd
    - 5 min/30 min =16%
  - Upper extremity training=HIIT
    - Increases number of used muscle fibers = metabolic effect
Conclusions #2

- No
  - Don’t do it in rookies
    - MICE before AIT (<VO₂max) before HIIT
    - Compliance?
      - Wingate---study vs practice?
  - How many years will most people do multiple Wingate tests????
  - HITT performed right is pretty easy
    - Short hard segments
    - Adapt by reducing length of hard segments
  - It may pose health risks in older and/or less fit populations
    - ACSM Screening for medical clearance
    - Do conventional background training first
    - Progress intensity gently