Queen Mary University of London

Barts and The London School of Medicine and Dentistry

Intensity and volume of high intensity interval training necessary to reduce cardiometabolic risk: a systematic review

Emily Morrison

Brighton and Sussex Medical School

1. Introduction

With one of the most commonly cited reasons for lack of physical activity participation being 'lack of time',[1] high-intensity interval training (HIIT; involving short-to-long periods of high-intensity exercise separated by periods of relative recovery or rest) offers a time-efficient method for reducing cardiometabolic risk.

Various HIIT programmes have been shown to be effective at improving insulin sensitivity, aerobic exercise capacity, blood pressure, body composition and vascular function, to a similar extent as moderate intensity continuous training (MICT), with a lower total exercise time.[2,3,4]

Despite this, the optimum protocol is unknown. Programmes vary in type, duration, intensity and volume, and little is known about varying HIIT characteristics or whether there is a dose-response relationship.

2. Aims

To examine the type, intensity, interval duration and volume of HIIT best suited to producing improvements in cardiometabolic risk in healthy, overweight or obese adults, in order to produce a recommended protocol.

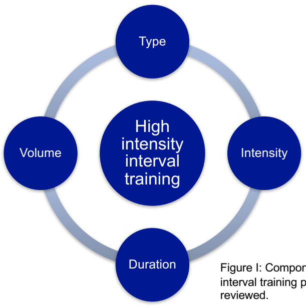

Figure I: Components of high intensity interval training programmes to be reviewed.

3. Methods

Literature search

A literature search of PubMed, The Cochrane Library, Embase and Web of Science was performed on 8th October 2016 using relevant search terms and citations retrieved from inception.
Additional papers were identified using Google Scholar citation searching and PubMed related articles. The PRISMA statement was followed.[5]

Inclusion criteria	Exclusion criteria
Randomised controlled trials comparing HIIT to a control group or MICT	Non-randomised controlled trials or other trial design
Trials evaluating a HIIT programme and at least one cardiometabolic risk factor	Wider intervention than HIIT alone e.g. diet or lifestyle changes
HIIT programme lasting ≥2 weeks	Non-English language or animal studies
	Child, adolescent or athlete participants
	Pre-existing cardiovascular, metabolic or other health conditions

Table I: Inclusion and exclusion criteria for studies to be included in the review.

Data extraction

Data extracted from studies included demographics, HIIT intervention programme characteristics and cardiometabolic outcomes (percentage change from baseline in anthropometric measurements, glucose regulation, lipids, blood pressure and $\dot{V}O_{2max}$).

Quality assessment

Studies were quality assessed using the 10 point Physiotherapy Evidence Base Database (PEDro) scale.[6]

4. Results

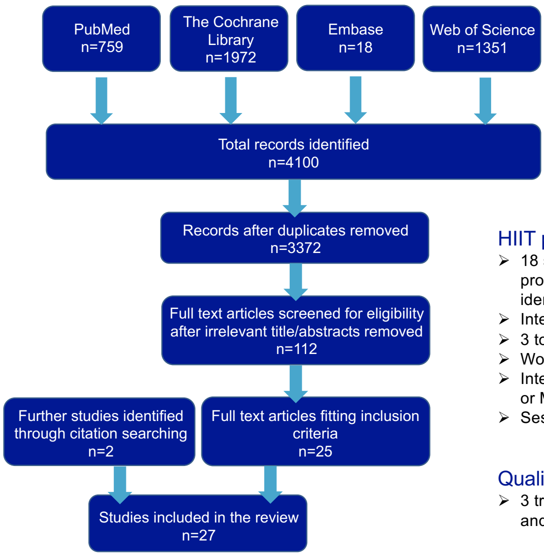

Figure II: Flow chart of study selection at each stage from identification to final inclusion.

HIIT programme variation

- 18 static cycling and 9 running HIIT programmes on a treadmill or outdoor track identified
- Intervention periods of 2 to 16 weeks
- 3 to 5 exercise sessions per week
- Work interval durations of 8s to 4 minutes
- Intensity greater than 80% HRMax, $\dot{V}O_{2max}$ or Max-AP
- Sessions 8 to 61 minutes duration

Quality assessment

- 3 trials achieved high quality, 22 moderate and 2 poor quality scores.

Protocol characteristics

Different characteristics are important in the reduction of risk for specific cardiometabolic outcome measures:

Aerobic power: $\dot{V}O_{2max}$ increased in all interventions >3 weeks duration except one, with increases of 2.8-33%
Body composition: Greatest changes with programmes ≥12 weeks and longer duration sessions
Insulin sensitivity: Improvements after 4 weeks in programmes involving 30s-2minute high intensity intervals only
Lipids: Four studies with variable HIIT protocols displayed improvements in lipid levels
Blood pressure: No change seen in any study <12 weeks duration or with sessions <30minutes duration

- No benefit was seen when comparing active recovery to complete rest
- The effect of changing work:rest ratio was unclear
- It is not possible to infer the effects of varying the intensity of high-intensity intervals.

5. Discussion

Limited high-quality studies investigating the effects of HIIT protocols on cardiometabolic risk factors were identified. However protocol recommendations best suited for programme success, to be used by healthcare providers and the general public, can be made.

Results suggest that the HIIT protocol with greatest potential for improvement in a wide range of cardiometabolic markers would involve **3 times weekly** sessions with intervals of **30s-2minutes** over sessions of **30-47minutes**. Programme duration should be **≥12 weeks.** This varies from previous recommendations made based on targeted improvements in cardiorespiratory fitness alone.[7]

This review was limited by small sample sizes in studies and vast differences in HIIT protocols compared, making comparisons of intensity, interval duration, repetitions and outcomes difficult. Few studies have investigated the effects of HIIT programmes over 12 weeks duration, and in order to recommend long-term HIIT exercise therapy, the long-term effects of longer interventions must be assessed.

6. Conclusion

The optimal amount of HIIT is difficult to determine and varies due to individual responses. However, protocol characteristics best suited to reducing risk in a wide range of cardiometabolic outcomes can be predicted.

Future studies are necessary to evaluate the effects of varying HIIT protocol characteristics on cardiometabolic outcomes. In reality, many people are likely to combine HIIT with other types of training and it would be valuable to determine the optimal ratio of HIIT to continuous training over longer periods.

References

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Stephanie Hemmings, Dylan Morrissey and Christian Barton
Centre for Sport and Exercise Medicine, Queen Mary University of London

Contact - E.Morrison1@uni.bsms.ac.uk