VCE Physical Education
Units 3 and 4, 2018–2024

Clarification of content:
High intensity interval training (HIIT)

Introduction

This supplementary material has been developed and revised to guide teachers in the approach taken to high intensity interval training (HIIT) as part of VCE Physical Education (2018–2024).

The information provided specifically relates to VCE Physical Education, Unit 4: Training to improve performance, Area of Study 2. This includes the key knowledge of:

* training methods including continuous, interval (short, intermediate, long and high intensity), fartlek, circuit, weight/resistance, flexibility and plyometrics.
* chronic adaptations of the cardiovascular, respiratory and muscular systems to aerobic, anaerobic and resistance training.

Summary of update

Feedback from teachers collected through the VCE monitoring process in 2021 indicated students required further clarity around the HIIT method.

This document replaces the previous HIIT supplementary material document, noting that the concept of HIIT training is relatively new and research continues to be published.

A summary of the changes outlined in this updated HIIT document:

* Simplification of accepted intensity for work periods
* A focus on sustaining intensity close to VO2 max during a repetition and accumulating duration spent close to VO2 max throughout the training session
* A focus on students showing an understanding of the influence work time and recovery type and time has on the design of an appropriate HIIT protocol
* Accepted adaptations that can be developed through HIIT training expanded to include cardiovascular adaptations associated with other forms of aerobic training.

What is high intensity interval training (HIIT)?

Although there is no universal definition for high intensity interval training (HIIT), for the purposes of VCE Physical Education 2018–2024, the following definition is used:

High intensity interval training is a form of training that includes work periods of high intensity (90–100% VO2 max or 90–100% HR max) exercise interspersed with periods of passive rest or low intensity active recovery.

While the term HIIT is associated with various forms of training, for VCE Physical Education HIIT describes repetitive activities such as cycling (on a stationary bike), running (sprinting), rowing or swimming and is primarily used to improve aerobic power.

How can the training principles be correctly applied to HIIT?

HIIT sessions vary depending on the work period, intensity, number of repetitions and time of the recovery periods. The possible variations are numerous and there is not a precise prescription to elicit aerobic adaptations. However, it is generally accepted that optimal improvements occur when the following training protocols are followed.

Intensity

* The focus should be on reaching and sustaining an exercise intensity close to VO2 max (90–100% VO2 max or 90–100% HR max) per repetition.
* The accumulated duration of intensity spent at 90–100% VO2 max or 90–100% HR max should exceed several minutes across the training session.

Time

* The commonly accepted work time per repetition is between 30 seconds and 4 minutes. Given the aim is to reach and sustain intensities close to VO2 max or HR max, a shorter work period is likely to require more repetitions than a session with longer work periods (see example in Table 1).
* The overall time of the training session, including work and recovery periods, could total less than the accepted 20 minute minimum for other aerobic training methods due to the increased intensity.

Recovery

* Research has found no distinct difference when using a passive or active recovery in the ability to accumulate time spent working close to VO2 max within a session.
* An accepted low intensity active recovery between repetitions would be approximately 50% VO2 max or 60% HR max.
* Due to the time required to increase acute responses of the cardiorespiratory system, the choice of recovery needs to be considered when determining work periods. For example, if a passive recovery is used an individual would be expected to complete more repetitions than if an active recovery is used (for the same work period), to accumulate a similar time spent close to VO2 or HR max (see Table 1 for example).
* While a fixed work to recovery ratio has not been established in current research, for the purposes of VCE Physical Education a work to recovery ratio for HIIT sessions of between 1:1 and 2:1 is deemed suitable.

Table 1 (on the following page) displays accepted ranges and examples for designing a HIIT training session. The ‘overview of accepted ranges’ row provides a guideline for accepted ranges for appropriate HIIT protocols and is a starting point for students. The four examples that follow the overview provide specific examples of how work period time and type of recovery can influence the structure of a session.

**Table 1: Examples of accepted high intensity interval training (HIIT) session protocols**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Frequency | Intensity | Type | Repetitions | Work period | Recovery period | Recovery type and intensity | Work to recovery ratio |
| **Overview of accepted ranges** | 3 × week | * 90–100% VO2 max
* 90–100% HR max
 | Repetitive activity such as cycling or running | 4–12 | 30 seconds – 4 minutes | 30 seconds – 4 minutes  | Passive (rest) or active recovery (~50% VO2 max or 60% HR max)  | 1:1 or 2:1 |
| **Example 1 (Shorter work periods)** | 3 × week | * 90–100% VO2 max
* 90–100% HR max
 | Cycling or running | 10 | 45 seconds | 45 seconds | Passive (rest) or active recovery (~50% VO2 max or 60% HR max) | 1:1 |
| **Example 2 (Longer work periods)** | 3 × week | * 90–100% VO2 max
* 90–100% HR max
 | Cycling or running | 4 | 2 minutes  | 60 seconds | Passive (rest) or active recovery (~50% VO2 max or 60% HR max)  | 2:1 |
| **Example 3 (Active recovery)** | 3 × week | * 90–100% VO2 max
* 90–100% HR max
 | Cycling or running | 10 | 30 seconds  | 30 seconds | Active recovery (~50% VO2 max or 60% HR max) | 1:1 |
| **Example 4****(Passive recovery)** | 3 × week | * 90–100% VO2 max
* 90–100% HR max
 | Cycling or running | 12 | 30 seconds  | 30 seconds | Passive (rest) | 1:1 |

What chronic adaptations occur with HIIT?

HIIT has been shown to be an effective form of training to improve exercise capacity (increased maximum oxygen consumption, or VO2 max) and performance (faster time trials or longer time to exhaustion) in activities that are aerobic in nature.

Since publication of the initial HIIT supplementary material document, further research has been published that indicates similar cardiovascular adaptations can be developed from HIIT training as for other forms of aerobic training. Therefore, note additional cardiovascular adaptations (marked in bold, with an asterisk) have been added to the list below.

Chronic adaptations to HIIT training can include:

* creased VO2 maximum
* increased capillarisation
* reduced systolic and diastolic blood pressure
* an increase in mitochondrial mass
* an increase in muscle oxidative capacity
* an increase in muscle buffering capacity
* an increase in resting muscle glycogen content
* a decrease in rate of glycogen use
* a decrease in lactate production
* improved lactate tolerance
* a reduced reliance on carbohydrate as a fuel source during exercise
* **increased arterio-venous oxygen difference (a-vO2 difference)\***
* **increased stroke volume\***
* **increased maximal cardiac output\***
* **increased blood volume (including haemoglobin count and plasma volume)\***
* **decreased resting and submaximal heart\***

What about other uses of the term HIIT? How are these different to HIIT within VCE Physical Education?

As noted above, the term HIIT has been used to describe different types of training. Many commercial gyms use the term HIIT to describe training sessions that include muscle-strengthening exercises (for example, CrossFit training). These types of sessions include both aerobic and muscle-strengthening exercises performed at a high intensity and generally lead to improvements in aerobic parameters as well as strength and flexibility.

HIIT within VCE Physical Education focuses on achieving aerobic adaptations by using one type of activity such as cycling or running, without a muscle-strengthening component.

Table 2 highlights the differences between the definition of HIIT used within VCE Physical Education and the definition of HIIT that is commonly used within a commercial gym.

**Table 2: Key differences between the use of HIIT in VCE Physical Education and commercial gyms.**

|  |  |
| --- | --- |
| **HIIT within VCE Physical Education** | **Commercial gym application of the term HIIT** |
| Unimodal exercises (running, cycling, swimming or rowing) | Multimodal exercises – whole body, universal motor recruitment patterns in multiple planes of movement, e.g. squats, pull-ups, jumps |
| Conducted in set intervals | Conducted in a circuit or interval format |
| Defined rest period | Rest breaks taken ‘as needed’ (dependent on the individual) |

What similarities and differences exist between HIIT, other forms of interval training (long, intermediate and short) and fartlek training?

HIIT training shares similarities and differences with other forms of interval training and fartlek training. The key difference relates to the type of training: HIIT, long interval and fartlek training are considered aerobic training methods, whereas short and intermediate interval training are anaerobic training methods.

Table 3 outlines some of the similarities and differences between HIIT, other interval training methods and fartlek training.

**Table 3: Similarities and differences between HIIT and other forms of interval training (long, intermediate, short) and fartlek training**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **HIIT** | **Long interval**  | **Intermediate interval** | **Short interval** | **Fartlek** |
| Aerobic training method | Aerobic training method | Anaerobic training method | Anaerobic training method | Aerobic training method A continuous activity completed within the aerobic training zone (~70–85% HR max) that alternates bursts of speed with moderate intensity activity.Note: Not a type of interval training. |
| Work period intensity between 90–100% VO2 max or 90–100% HR max | Work period intensity completed at or just below lactate inflection point (LIP) (~80–85% HR max) | Work periods completed above LIP (~85–90% HR max) | Work periods completed at maximal intensity (95% ≤ HR max) | No defined work periods like interval training. However, bursts of speed are completed at an intensity at the top of the aerobic training zone, close to LIP (~80–85% HR max).  |
| Work period time 30 seconds – 4 minutes | Work period time 60 seconds – 5 minutes | Work period time 10–60 seconds | Work period time 3–10 seconds  | No defined work periods |
| Rest periods can be active or passive. Active recovery completed at low intensity (~60% HR max – below aerobic training zone) | Rest periods can be active or passive | Rest periods are passive | Rest periods are passive | No ‘rest’ periodsModerate intensity periods are completed at the lower end of the aerobic training zone (70–75% HR max).  |
| To achieve aerobic adaptations overall session time could be shorter than long interval (due to higher intensity). | To achieve aerobic adaptations overall session time should be at least 20 minutes. | N/A. Anaerobic training method designed to achieve anaerobic adaptations.  | N/A. Anaerobic training method designed to achieve anaerobic adaptations.  | To achieve aerobic adaptations overall session time should be at least 20 minutes. |

What are the potential benefits of HIIT over other forms of aerobic training?

When compared to other forms of training designed to improve aerobic power, HIIT has a lesser time commitment but can achieve similar health benefits, including decreased blood pressure, decreased bad (LDL) cholesterol and a reduction in insulin resistance. The mechanism of benefit is related to the greater energy expenditure following the exercise session due to the longer and more energy expensive recovery period following the HIIT sessions.

HIIT is a time efficient form of exercise to induce rapid muscle and performance adaptations that compare to more traditional endurance training models. HIIT has been shown to improve aerobic fitness (VO2 max) in 2–12 weeks of training.

HIIT has also been associated with greater enjoyment of training when compared to moderate intensity continuous training, which may be relevant for improving training adherence. HIIT has been criticised as potentially being unsafe, impractical and intolerable for some individuals. With correct medical guidance, HIIT has been safely used across many different disease states – for example, type 2 diabetes, coronary artery disease (CAD), heart failure, hypertension, metabolic syndrome, obesity and polycystic ovarian syndrome (PCOS).

Conclusion

For the purposes of VCE Physical Education (2018–2024) it is expected that students should be able to:

* define the term HIIT
* describe HIIT protocols: intensity, duration of work and rest/recovery periods and repetitions
* demonstrate the influence work time and recovery type and time have on the design of an appropriate HIIT protocol
* design, evaluate and critique a training program incorporating HIIT
* identify and explain the physiological chronic adaptations to HIIT
* describe how HIIT can improve performance.

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