VCE Physical Education  
Units 3 and 4, 2025–2029

Clarification of content:   
High intensity interval training (HIIT)

Introduction

This supplementary material has been developed to guide teachers in the approach taken to high intensity interval training (HIIT) as part of VCE Physical Education (2025–2029).

The information provided specifically relates to VCE Physical Education, Unit 4 Area of Study 2: How is training implemented effectively to improve fitness? This includes the key knowledge of:

* training program principles, including frequency, intensity, time/duration, type, progression, specificity, individuality, diminishing returns, variety, maintenance, tapering, overtraining and detraining
* training methods, including continuous, interval (short, intermediate, long and HIIT), fartlek, circuit, weight/resistance, flexibility and plyometrics
* chronic adaptations of the cardiovascular, respiratory and muscular systems to aerobic, anaerobic and resistance training that produce improvements in:
* VO2 max
* lactate inflection point (LIP)
* speed and force of muscular contraction
* lactate tolerance.

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 2019–2025, 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 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.

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’ periods  Moderate 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 (2019–2025) 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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References

Abderrahmane, AB, Prioux, J, Mrizek, I, Chamari, K, Tabka, Z, Bouslama, A, & Zouhal, H (2013). Recovery (passive vs. active) during interval training and plasma catecholamine responses[. *International Journal of Sports Medicine*,](https://doi.org/10.1055/s-0032-1327697)34(08), 742–747.

Abderrahman, AB, Zouhal, H, Chamari, K, Thevenet, D, de Mullenheim, PY, Gastinger, S, Tabka, Z & Prioux, J (2013). Effects of recovery mode (active vs. passive) on performance during a short high-intensity interval training program: a longitudinal study. [*European Journal of Applied Physiology*](https://www.thieme-connect.de/products/ejournals/abstract/10.1055/s-0032-1327697), 113(6), 1373–1383.

Astorino, T, Edmunds, R, Clark, A, King, L, Gallant, R, Namm, S, Fischer, A & Wood, K (2016). High-Intensity Interval Training Increases Cardiac Output and VO2max. [*Medicine & Science in Sports &*](http://dx.doi.org/10.1249/MSS.0000000000001099) *Exercise*, 49(1).

Bartlett, J, Close, G, Maclaren, D, Gregson, W, Drust, B, & Morton, J (2011). High-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise: Implications for exercise adherence. *Journal of Sports Science*, 29(6), 547–553.

Barlett, JD, Hwa Joo, C, Jeong, T-S, Louhelainen, J, Cochran, AJ, Gibala, MJ, Gregson, W, Close, GL, Drust, B, & Morton, JP (2012). Matched work high-intensity interval and continuous running induce similar increases in PGC-1α mRNA, AMPK, p38, and p53 phosphorylation in human skeletal muscle. *Journal of Applied Physiology*, 112, 1135–1143.

Dorado, C, Sanchis-Moysi, J, & Calbet, JAL (2004). Effects of recovery mode on performance, O2 uptake, and O2 deficit during high-intensity intermittent exercise. [*Canadian Journal of Applied*](https://doi.org/10.1139/h04-016) *Physiology*, 29(3), 227–244.

Feito, Y, Heinrich, KM, Butcher, SJ, & Carslo Poston, WS (2018). High-intensity functional training (HIFT): Definition and research implications for improved fitness. *Sports*, 6(3), 76.

Forbes, S, Slade, J, & Meyer, R (2008). Short-term high-intensity interval training improves phosphocreatine recovery kinetics following moderate-intensity exercise in humans. *Applied Physiology, Nutrition, and Metabolism*, 33, 1124–1131.

García-De Frutos, JM, Orquín-Castrillón, FJ, Marcos-Pardo, P, Rubio-Arias, J, & Martínez-Rodríguez, A (2021). Acute Effects of Work Rest Interval Duration of 3 HIIT Protocols on Cycling Power in Trained Young Adults.[*International Journal of Environmental Research and Public Health*](http://dx.doi.org/10.3390/ijerph18084225), 18(8), 4225.

Gibala, MJ (2018). Functional high intensity training: A HIT to improve insulin sensitivity in type 2 diabetes. *Experimental Physiology*, 103(7), 937–938.

Gibala, MJ, & Hawley, JA (2017). Sprinting toward fitness. *Cell Metabolism*, 988–990.

Gibala, MJ, & McGee, SL (2008). Metabolic adaptations to short-term high-intensity interval training: a little pain for a lot of gain? *Exercise and Sport Sciences Reviews*, 36(2), 58–63.

Gibala, MJ, Little, JP, MacDonald, MJ, & Hawley, JA (2012). Physiological adaptations to low-volume, high intensity interval training in health and disease. *The Journal of Physiology*, 590(5), 1077–1084.

Gibala, MJ, Little, JP, van Essen, M, Wilkin, GP, Burgomaster, KA, Safdar, A, Raha, S, & Tarnopolsky, MA (2006). Short‐term sprint interval versus traditional endurance training: similar initial adaptations in human skeletal muscle and exercise performance. *The Journal of Physiology*, 575(3), 901–911.

Haff, GG, & Triplett, NT (eds) (2015). *Essentials of Strength Training and Conditioning 4th Edition*. Human Kinetics.

Hawley, JA, Hargreaves, M, Joyner, MJ., & Zierath, JR (2014). Integrative biology of exercise. *Cell*, 159, 738–749

Helgerud, J, Høydal, KL, Wang, E, Karlsen, T, Berg, PR, Bjerkaas, M, Simonsen, T, Helgesen, CS, Hjorth, NL, Bach, R, & Hoff, J (2007). Aerobic high-intensity intervals improve VO2max more than moderate training. *Medicine and Science in Sports and Exercise*, 39 4, 665–671 .

Jensen, L, Bangsbo, J, & Hellsten, Y (2004). Effect of high intensity training on capillarization and presence of angiogenic factors in human skeletal muscle, *The Journal of Physiology*, 557(2), 571–582.

Keating, SE, Johnson, NA, Mielke, GI, & Coombes, JS (2017). A systematic review and meta‐analysis of interval training versus moderate‐intensity continuous training on body adiposity. *Obesity Reviews,* 18(8), 943–964.

Little, JP, Safdar, A, Wilkin, GP, Gibala, MJ, & Tarnopolsky, MA (2010). A practical model of low‐volume high‐intensity interval training induces mitochondrial biogenesis in human skeletal muscle: potential mechanisms. *The Journal of Physiology*, 588(6), 1011–1022.

MacInnis, MJ, & Gibala, MJ (2017). Physiological adaptations to interval training and the role of exercise intensity. *The Journal of Physiology*, 595(9), 2915–2930.

Mahjoub, H, Le Blanc, O, Paquette, M, Imhoff, S, Labrecque, L, Drapeau, A, Poirier, P, Bédard, É, Pibarot, P, & Brassard, P (2019). Cardiac remodeling after six weeks of high-intensity interval training to exhaustion in endurance-trained men. [*American Journal of Physiology. Heart and Circulatory Physiology*,](https://doi.org/10.1152/ajpheart.00196.2019) 317(4), H685–H694.

Matsuo, T, Saotome, K, Seino, S, Shimojo, N, Matsushita, A, Iemitsu, M, Ohshima H, Tanaka, K, & Mukai C (2014). Effects of a low-volume aerobic-type interval exercise on VO2max and cardiac mass. *Med. Sci. Sports Exerc.* 46, 42–50.

Millet, GP, Candau, R, Fattori, P, Bignet, F, & Varray, A (2003). VO2 responses to different intermittent runs at velocity associated with VO2max. *Canadian Journal of Applied Physiology = Revue Canadienne De Physiologie Appliquee*, 28(3), 410–423.

Raleigh, JP, Giles, MD, Islam, H, Nelms, M, Bentley, RF, Jones, JH, Neder, JA, Boonstra, K, Quadrilatero, J, Simpson, CA, Tschakovsky, ME, & Gurd, BJ (2018). Contribution of central and peripheral adaptations to changes in maximal oxygen uptake following 4 weeks of sprint interval training. *Appl. Physiol. Nutr. Metab.*, 43, 1059–1068.

Stepto, N, & Shaw, C (2012). Fast and furious: intensity is the key to health and fitness. *The Conversation*.

Stepto, N, & Shaw, C (2013). Health Check: high-intensity micro workouts vs traditional regimes. *The Conversation*.

Talanian, JL (2015). Defining Different Types of Interval Training: Do we need to use more specific terminology?. [*Sports and Exercise Medicine – Open Journal*.](http://dx.doi.org/10.17140/SEMOJ-1-124) 1, 161–163.

Warburton, DE , Haykowsky, MJ, Quinney, HA, Blackmore, D, Teo, KK, Taylor, DA, McGavock, J & Humen, DP (2004). Blood Volume Expansion and Cardiorespiratory Function: Effects of Training Modality. [*Medicine & Science in Sports & Exercise*,](https://doi.org/10.1249/01.mss.0000128163.88298.cb) 36 (6), 991–1000.

Weston, KS, Wisløff, U, & Coombes, JS (2014). High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. *British Journal of Sports Medicine*, 48(16), 1227–1234.

Wewege, MA, Ahn, D, Yu, J, Liou, K, & Keech, A (2018). High‐Intensity Interval Training for Patients With Cardiovascular Disease – Is It Safe? A Systematic Review. *Journal of the American Heart Association*, 7(21), e009305.